



BANGLADESH TECHNICAL EDUCATION BOARD
Agargaon, Dhaka-1207

4-YEAR DIPLOMA-IN-ENGINEERING PROGRAM
SYLLABUS (PROBIDHAN-2016)

MECHANICAL TECHNOLOGY
TECHNOLOGY CODE: **670**

6th SEMESTER

DIPLOMA IN ENGINEERING
PROBIDHAN-2016

MECHANICAL TECHNOLOGY
6th SEMESTER

Sl. No	Subject Code	Name of the subject	T	P	C	Marks				Total
						Theory		Practical		
						Cont. assess	Final exam	Cont. assess	Final exam	
1	67061	Thermodynamics & Heat Engine	3	3	4	60	90	25	25	200
2	67062	Mechanical Measurement & Metrology	2	3	3	40	60	25	25	150
3	67063	Plant Engineering	2	3	3	40	60	25	25	150
4	67064	Strength of Materials	3	3	4	60	90	25	25	200
5	67065	Advance Welding -2	2	3	3	40	60	25	25	150
6	65852	Industrial Management	2	0	2	40	60	-	-	100
Total			14	18	19	280	420	125	125	950

AIMS

To provide the students with an opportunity to acquire knowledge, skill and attitude in the area of thermodynamics and heat engine with special emphasis on:

- heat and temperature
- thermodynamic systems, laws and processes
- properties of steam
- thermodynamic cycle
- internal combustion engines

SHORT DESCRIPTION:

Scope of thermodynamics; Heat and heat units; Temperature and its scales; Thermodynamic systems; Thermodynamic laws & processes; Properties of steam; Entropy and enthalpy; Thermodynamic cycles; internal combustion engines; Refrigeration.

DETAIL DESCRIPTION:**Theory:****1. Understand the scope and basic concept of thermodynamics.**

- 1.1 Define thermodynamics.
- 1.2 Mention different applications of thermodynamics in engineering field.
- 1.3 Define temperature.
- 1.4 Define heat.
- 1.5 Mention the units of heat and their conversion.
- 1.6 Distinguish between heat and temperature.
- 1.7 Compare the heat and work.
- 1.8 Solve problems on converting heat units.

2. Understand the concept of specific heat of gases.

- 2.1 Define specific heat, thermal capacity and water equivalent.
- 2.2 Describe the terms specific heat at constant pressure (C_p) and specific heat at constant volume (C_v).
- 2.3 Relate two specific heats (C_p and C_v).
- 2.4 Mention the value of C_p , C_v and γ for some common gases.

3. Understand the concept of latent heat and sensible heat.

- 3.1 Define sensible heat and latent heat.
- 3.2 Classify and explain of latent heats.
- 3.3 List the values of different latent heat for water and ice in different units.
- 3.4 Compute the formulae to calculate sensible heat and latent heat.
- 3.5 Solve problems on sensible heat, latent heat and total heat.

4. Understand the properties and laws of perfect gases.

- 4.1 Define perfect gas.
- 4.2 Explain the variables of perfect gases.
- 4.3 State Boyle's law, Charle's law and Gay-Lussac law.

- 4.4 Explain the general gas equation, characteristic gas equation and universal gas constant or molar constant.
- 4.5 State Joule's law and Avogadro's law.
- 4.6 Solve problems using gas laws and equations.
- 5. Understand the internal energy of gases.**
- 5.1 Define internal energy.
- 5.2 Explain the internal energy of gas heated at constant volume and constant pressure.
- 5.3 Express the derivation of the equation for increase in internal energy i.e.; $Q = m C_v (T_2 - T_1)$.
- 5.4 Solve problems on change of internal energy.
- 6. Understand the aspects of thermodynamic systems.**
- 6.1 Define thermodynamic system, boundary and surrounding.
- 6.2 Mention the classification of the thermodynamic systems.
- 6.3 Explain the closed system, open system and isolated system with example.
- 6.4 List the properties of thermodynamic systems.
- 7. Understand the laws of thermodynamics.**
- 7.1 State the laws of thermodynamics.
- 7.2 Explain the 1st law of thermodynamics.
- 7.3 Mention the significance and limitations of 1st law of thermodynamics.
- 7.4 Explain the 2nd law of thermodynamics.
- 7.5 Mention the application of 2nd law of thermodynamics in refrigeration cycle.
- 7.6 Solve problems on laws of thermodynamics.
- 8. Understand the thermodynamic processes of perfect gases.**
- 8.1 Define thermodynamic process.
- 8.2 Classify thermodynamic processes.
- 8.3 List the various thermodynamic processes of perfect gases.
- 8.4 Describe constant volume, constant pressure, isothermal and adiabatic thermodynamic processes with P-V & T-S diagrams.
- 8.5 Solve problems on thermodynamic processes.
- 9. Understand the entropy and enthalpy of perfect gases.**
- 9.1 Define entropy and enthalpy.
- 9.2 Mention the units of entropy and enthalpy.
- 9.3 Mention the significance of entropy and enthalpy.
- 9.4 Explain the relation between temperature and entropy.
- 9.5 Express the mathematical deduction of enthalpy.
- 9.6 Explain the change of entropy of a perfect gases and vapors during constant volume, constant pressure, isothermal and adiabatic thermodynamic processes.
- 9.7 Solve problems on entropy and enthalpy of above mentioned thermodynamic processes.
- 10. Understand the aspects of thermodynamic cycles.**
- 10.1 Classify and explain thermodynamic cycles.
- 10.2 List the assumption in thermodynamic cycles.
- 10.3 Explain the reversible and irreversible cycles.

- 10.4 State the meaning of air standard cycle, gas power cycle and vapor power cycle.
10.5 Describe the Carnot cycle, Otto cycle, and diesel cycle with P-V and T-S diagrams.

11. Understand the features of internal combustion engine.

- 11.1 State the meaning of internal combustion (IC) engine.
11.2 Classify IC engines.
11.3 Define bore, stroke, clearance volume, swept volume, total volume and compression ratio.
11.4 Distinguish between the 2-stroke and 4-stroke engines.
11.5 Identify the stationary parts and moving parts of IC engine.
11.6 Mention the function of major IC engine components.

12. Understand the features of petrol engine.

- 12.1 Mention the principle of operation of a 4-stroke and a 2-stroke petrol engine.
12.2 Compare the 2-stroke and 4-stroke petrol engines.
12.3 Describe the construction and components of petrol engine.
12.4 Mention the uses of petrol engine.

13. Understand the features of diesel engine.

- 13.1 Mention the principle of operation of a 4-stroke and a 2-stroke diesel engine.
13.2 Compare 2-stroke and 4-stroke diesel engine.
13.3 Describe the construction and components of diesel engine.
13.4 Mention the uses of diesel engine.

14. Understand the properties of steam.

- 14.1 Define steam.
14.2 Explain the formation of steam at constant pressure.
14.3 Describe the important terms for steam (wet steam, dry saturated steam, superheated steam, dryness fraction, quality of wet steam, specific volume of steam, etc.).
14.4 Explain the method of using steam table.
14.5 Describe the internal energy of steam.
14.6 Explain the Mollier diagram.

15. Understand the features of refrigeration.

- 15.1 State the meaning of refrigeration.
15.2 Define and classify refrigerants.
15.3 Explain unit of refrigeration and coefficient of performance (COP).
15.4 Describe the reverse Carnot cycle with P-V and T-S diagrams.
15.5 Describe the vapor compression mechanical refrigeration cycle.
15.6 Solve the problem related to unit of refrigeration and coefficient of performance (COP).

PRACTICAL:

1. Verify Boyle's law with Boyle's law test apparatus i.e. $P_1V_1 = P_2V_2 = \dots = \text{constant}$.

- 1.1 Collect a high pressure type Boyle's law test apparatus.
1.2 Connect pressure pump with apparatus.
1.3 Note the fluid pressure and volume.
1.4 Create pressure by hand pumper.
1.5 Note the fluid pressure and volume (at least 5 reading).
1.6 Draw volume-pressure diagram & volume inverse pressure diagram.
1.7 Verify $P_1V_1 = P_2V_2 = \dots = \text{constant}$.

1.8 Release fluid pressure and disconnect the pumper for further use the apparatus.

1.9 Prepare report and submit.

2. Verify Gay-Lussac law by measuring pressure of the refrigeration cylinder in different temperature.

i.e. $\frac{P_1}{T_1} = \frac{P_2}{T_2} \dots\dots\dots = \text{constant.}$

3. Observe the 4-stroke Otto cycle with a model.

3.1 Collect a 4-stroke petrol engine model.

3.2 Operate crank handle up to piston move TDC position.

3.3 Observe piston at TDC position intake valve open & exhaust valve closed position.

3.4 Operate crank handle until end of suction stroke (Piston at BDC position).

3.5 Operate crank handle until end of compression stroke and observe piston and valves position.

3.6 Operate crank handle up to end of expansion stroke and observe piston and valves position.

3.7 Operate crank handle up to end of exhaust stroke and observe piston and valves position.

3.8 After one cycle complete then draw P-V diagram of Otto cycle.

4. Observe the 4-stroke diesel cycle with a model.

4.1 Collect a 4-stroke diesel engine model.

4.2 Operate crank handle up to piston move TDC position.

4.3 Observe piston at TDC position intake valve open & exhaust valves closed position.

4.4 Operate crank handle until end of suction stroke (Piston at BDC position).

4.5 Operate crank handle until end of compression stroke and observe piston and valves position.

4.6 Operate crank handle up to end of expansion stroke and observe piston and valves position.

4.7 Operate crank handle up to end of exhaust stroke and observe piston and valves position.

4.8 After one cycle complete then draw P-V diagram of diesel cycle.

4.9 Prepare report and submit.

5. Observe the 2-stroke diesel cycle with a model.

5.1 Collect a 2-stroke diesel engine model.

5.2 Operate crank handle up to piston move BDC position.

5.3 Observe port/valve position.

5.4 Operate crank handle until piston move TDC position.

5.5 Observe inlet port, exhaust valve, super charger operation.

5.6 Operate crank handle up to piston move BDC position.

5.7 Observe inlet port, exhaust valve, super charger operation.

5.8 Find out 4-events of two stroke diesel cycle.

5.9 After one cycle complete then draw P-V diagram of two stroke diesel cycle.

5.10 Prepare report and submit.

6 Determine the mechanical equivalent of heat by Joule's apparatus to verify first law of thermodynamics.

7 Identify the major components of internal combustion engine.

7.1 Collect an IC engine and required tools & equipments.

7.2 Loosen nut-bolt and separate engine head, engine block and oil pan.

7.3 Observe and identify different part of engine head.

7.4 Observe and identify different part of engine block crank case.

7.5 Observe and identify different part of oil pan.

7.6 Note down observation.

7.7 Re-install engine head, engine block and oil pan.

7.8 Prepare report and submit.

8 Identify the stationary and moving engine parts of IC engine.

- 8.1 Collect an IC engine required tools & equipments.
- 8.2 Loosen nut-bolt and separate engine tappet cover.
- 8.3 Crank the engine.
- 8.4 Observe and identify different stationary part of engine.
- 8.5 Observe and identify different moving part of engine.
- 8.6 Note down observation.
- 8.7 Re-install engine tappet cover.
- 8.8 Prepare report and submit.

9 Identify the components of diesel engine.

- 9.1 Collect a diesel engine and required tools & equipments.
- 9.2 Loosen nut-bolt and separate engine tappet cover
- 9.3 Observe and identify major component of diesel engine.
- 9.4 Note down observation.
- 9.5 Prepare report and submit.

10 Identify the components of petrol/gasoline engine.

- 10.1 Collect a petrol/gasoline engine and required tools & equipments.
- 10.2 Loosen nut-bolt and separate engine tappet cover
- 10.3 Observe and identify major component of petrol/gasoline engine.
- 10.4 Note down observation.
- 10.5 Re-install engine tappet cover.
- 10.6 Prepare report and submit.

11 Study a vapor compression refrigeration cycle with trainer model.

- 11.1 Collect a trainer board of vapor compression refrigeration cycle.
- 11.2 Identify basic components of vapor compression refrigeration cycle.
- 11.3 Identify auxiliary components of vapor compression refrigeration cycle.
- 11.4 Identify high & low side components of vapor compression refrigeration cycle.
- 11.5 Operate the vapor compression refrigeration cycle and measure temperature of different components & sections.
- 11.6 Draw the T-S diagram of vapor compression refrigeration cycle.
- 11.7 Prepare report and submit.

REFERENCE BOOKS

- 1 Engineering Thermodynamics - R.S.Khurmi
- 2 Engineering Thermodynamics – P.K. Nag
- 3 Heat and Thermodynamics – Brij lal N. Subrahmanyam
- 4 Thermal Engineering - A. S. Sarao
- 5 Power Plant Engineering – G. R. Nagpal
- 6 Heat Engineering – V. P. Vasandani & D. S. Kumar

AIMS

- To be able to understand the concept and purpose of metrology in engineering production.
- To be able to evaluate measuring tools, instruments and equipment considering their use and purpose.
- To be able to perform linear, angular, surface measurement by precision and non-precision measuring instruments.
- To be able to appreciate the principles and techniques of care and maintenance of inspection & testing tools, instruments and equipment.

SHORT DESCRIPTION

Metrology; Non-precision measuring instruments; Precision measuring instruments; Angular measuring instruments; Optical instruments; Limits, fits and tolerances; Surface inspection & measurement; Machine tool inspection; Non-destructive tests; Screw thread measurement; Quality control; Recent trends in engineering metrology.

DETAIL DESCRIPTION**Theory:****1. Understand concepts of metrology.**

- 1.1 Define metrology.
- 1.2 Mention the objectives of metrology.
- 1.3 Describe different types of inspection techniques.
- 1.4 Relate precision, accuracy and cost of inspection.
- 1.5 Mention source of error in measurement.
- 1.6 Describe cosine error.
- 1.7 Explain the effect of temperature, pressure and alignment on precision measuring instruments.
- 1.8 Describe the general care of measuring instruments and calibration techniques.

2. Understand concepts of non-precision measuring instruments.

- 2.1 Define non-precision measuring instruments.
- 2.2 Describe the construction and uses of straight edge, spirit level, radius gauge, angle gauge, feeler gauge, combination set.
- 2.3 Describe the uses of tool maker's flat.
- 2.4 Describe use and care of surface plate, angle plate and V-Block.

3. Understand concept of precision measuring instruments.

- 3.1 Define precision measuring instruments.
- 3.2 Describe different types of vernier caliper.
- 3.3 Explain the vernier constant of the vernier caliper.
- 3.4 Mention the common uses for vernier instruments.
- 3.5 Explain the working principle of vernier height gauge, vernier bevel protractor, vernier depth gage, gear tooth vernier and dial gage.
- 3.6 Define micrometer & mention the different parts of a micrometer.
- 3.7 Explain the working principle of outside, inside, depth, screw, pipe, vernier, bench, digital and dial micrometers.
- 3.8 Describe & use different types of gauges and the Taylor's principle of gauges.
- 3.9 Describe the construction of slip, telescopic, hole, plug, ring, snap and length gauges, go or no go gauge.
- 3.10 Mention the uses of slip, telescopic, hole, plug, ring, snap and length gauges, go or no go gauge.

- 4. Understand concept of angular measuring instruments.**
 - 4.1 Mention the uses of angle gauge, vernier, protractor, vernier bevel protractor, sine bar and sine centre.
 - 4.2 Explain the principle of sine bar.
 - 4.3 Explain slip gauge and its different sets.
 - 4.4 Calculate the angles by using slip gauges and sine bar.
 - 4.5 Describe the procedure of using sine bar, sine center and sine table.
 - 4.6 Calculate angles of dovetail groove, V-groove and tapered hole.
 - 4.7 Calculate the size of dovetail groove, V-groove and tapered hole.
- 5. Understand concept the optical instruments used in surface inspection.**
 - 5.1 Describe the procedure of checking flatness by using optical flat.
 - 5.2 Describe the procedure of checking flatness by using a monochromatic light source.
 - 5.3 Describe the procedure of checking flatness by interferometer,
 - 5.4 Mention the uses of an auto-collimator or alignment telescope.
 - 5.5 Describe the working principle of auto-collimator.
 - 5.6 Explain the construction of an optical comparator.
 - 5.7 Describe the working principle of an optical comparator.
- 6. Understand concept of importance of limits, fits and tolerances of matching parts.**
 - 6.1 State the terms: basic size, nominal size, deviation, tolerances, clearance, allowance, limits of size, fits and zero line.
 - 6.2 Explain different types of tolerance.
 - 6.3 Describe interchangeable manufacture & the selective assembly of machine parts.
 - 6.4 Explain the ISO system of limits and fits.
 - 6.5 Solve problems related to limit, fits, clearance, allowance etc.
- 7. Understand concept of surface inspection and measurement.**
 - 7.1 Explain types of surface texture produced by various machine tools.
 - 7.2 Define roughness, waviness, flaws and lay and ISO method of indicating surface finish.
 - 7.3 Describe the surface inspection by comparison method.
 - 7.4 Describe the surface inspection by direct measuring methods using macro-interferometer, profilometer and diamond stylus analyser.
- 8. Understand concept of importance of checking accuracy of machine tools.**
 - 8.1 Identify the need for correct alignment.
 - 8.2 Explain the accuracy checking procedure of lathe, drill, milling machine.
 - 8.3 Describe the accuracy of checking procedure of shaper and grinding machines.
- 9. Understand the non-destructive tests.**
 - 9.1 Define non-destructive test.
 - 9.2 Describe the methods of non-destructive test.
 - 9.3 Describe the procedure of magnetic particle inspection.
 - 9.4 Describe the inspection process of engineering parts by x-ray.
 - 9.5 Describe the inspection procedure of engineering parts performed by radiography.
 - 9.6 Describe the procedure of ultrasonic inspection.
- 10. Understand the measuring method of different types of screw thread.**
 - 10.1 State screw threads terminology .
 - 10.2 Define best size wire.
 - 10.3 Drive and expression for best size wire.
 - 10.4 Explain the methods used in screw thread measurement with micrometer.
 - 10.5 Explain the methods used in screw thread measurement with Prism.
 - 10.6 Determine effective diameter of a screw with two/three wires method.
- 11. Understand concepts of quality control.**
 - 11.1 Explain the necessity of quality control in engineering production.
 - 11.2 Describe the statistical method of quality control.

- 11.3 Explain principle of TQM.
- 11.4 Describe sample inspection.
- 11.5 Describe different types of sampling.
- 11.6 Describe average control chart and deviation control chart.
- 11.7 Describe acceptance of sampling.

12. Understand the recent trends in engineering metrology.

- 12.1 List different methods of dimensional measurements using laser.
- 12.2 Mention the uses of electro-optical inspection.
- 12.3 State video metrology or vision metrology.
- 12.4 Describe laser telemetric system with schematic diagram.
- 12.5 Explain the working principle of laser inspection.
- 12.6 Describe uses of computer in the field of metrology.

PRACTICAL:

1. Study the common measuring instruments.

- 1.1 Select common measuring instruments.
- 1.2 Identify the major parts of the selected measuring instruments.
- 1.3 Inspect measuring instruments and determine any misalignment or other source of error in the instrument.
- 1.4 Clean, lubricate, assemble and re-calibrate the instrument.
- 1.5 Identify the measuring instruments for linear, angular, precision and non precision measuring instrument
- 1.6 Practice measuring system of various instruments.

2. Perform the linear measurement.

- 2.1 Select common measuring instruments for linear measurement.
- 2.2 Identify the major parts of vernier calipers, vernier micrometer, vernier and vernier height gauge.
- 2.3 Calculate vernier constant and least count of micrometer.
- 2.4 Determine diameter and length of a job by using vernier calipers.
- 2.5 Determine height of a job by vernier height gauge
- 2.6 Determine diameter and thickness of job by using vernier micrometer.

3. Perform angular measurement.

- 3.1 Determine the accuracies of simple angle gauge, combination set, vernier bevel protractor, sine bar using angle gauge blocks.
- 3.2 Identify the most accurate and least accurate method of determining angular measurement
- 3.3 Determine angles of workpieces by using a bevel protector and angle gauge.
- 3.4 Determine angles of various work pieces by using sine bar, sine center, dial indicator, slip gauges and surface plate.

4. Demonstrate various types of gauges.

- 4.1 Identify various types of gauges.
- 4.2 Compare the well known Taylor principle of gauge practice with standard workshop gauges.
- 4.3 Practice setting an adjustable snap gauge for GO and NO-GO tolerance zones.

5. Perform the measurement of screw thread.

- 5.1 Identify the inspection methods of measuring screw threads.
- 5.2 Determine the types & size of screw thread by using screw thread tables, steel rule, thread gauge and screw thread micrometer.
- 5.3 Find the effective diameter of a screw thread by using the two/three wire method.

6. Demonstrate various comparators and its operating.

- 6.1 Identify different types of comparators.

- 6.2 Demonstrate construction and operating principle of mechanical comparators.
 - 6.3 Set a dial indicator.
 - 6.4 Calibrate a dial indicator with slip gauges.
 - 6.5 Set up other types of comparators and test.
 - 6.6 Demonstrate checking alignment of a work piece using by dial indicator.
- 7. Perform the machine tool alignment.**
- 7.1 Identify essential features of machine tool alignment of various machine tools.
 - 7.2 Carry out level test with an engineering precision level.
 - 7.3 Determine alignment of spindle, tailstock, bed of a lathe, a milling machine and a pillar drilling machine using mandrels and dial indicator.
- 8. Perform surface finishing using various machine tools.**
- 8.1 Identify different types of various surface finishes.
 - 8.2 Produce a number of surface finishes using various machine tools.
 - 8.3 Test the surface texture by sight test, finger nails assessment and any other method available
- 9. Perform measurement of taper plug gauge by roller slip gauge and micrometer.**
- 9.1 Select to equal rollers slip gauge and micrometer.
 - 9.2 Set roller on slip gauge.
 - 9.3 Calculate measurement over two equal roller and height.
 - 9.4 Determine taper angle of plug gauge.
- 10. Perform measurement of Chordal thickness of gear.**
- 10.1 Select gear tooth vernier caliper.
 - 10.2 Calculate chordal addendum.
 - 10.3 Adjust vernier calipers on gear tooth.
 - 10.4 Determine chordal thickness of gear.
- 11. Understand care and maintenance of measuring instruments.**
- 11.1 Identify the areas of potential problems in measuring instruments.
 - 11.2 Dismantle, lubricate and re-assemble the measuring instruments.
 - 11.3 Identify correct cleaning techniques and lubricants to be used on measuring instruments.
 - 11.4 Instigate a preventative maintenance program for all measuring instruments in Mechanical Engineering Department.

REFERENCES:

1. Engineering Metrology – R.K Jain
2. Practical Engineering Metrology –K.W.B Sharp
3. Engineering Metrology – K.J. Hume, Macdonald
4. Industrial Metrology – Smith GT.
5. Hand Book of industrial Metrology – D.M Anthonoy

AIMS

- To be able to understand the concept, principles and techniques of installation and alignment of machinery and equipment.
- To be able to understand the maintenance procedure of plant machinery and equipment.
- To be able to trace out faults and to initiate proper maintenance of machinery.

SHORT DESCRIPTION

Installation and alignments of plant machinery; Bearings & journals; Plant maintenance; Assembling & fitting; Pipe work; Lubricants & additives; Boiler; Steam turbines; Gas turbines; Industrial faults & its causes.

DETAIL DESCRIPTION**Theory:****1. Understand the principles of installation and alignment of plant machinery.**

- 1.1 Define plant and plant engineering.
- 1.2 Define installation and alignment.
- 1.3 Explain the need of proper installation and proper alignment of plant machinery.
- 1.4 Define site preparation.
- 1.5 Explain the factors of site preparation in consideration of the floor.
- 1.6 Identify the vibration factor in consideration of the floor.
- 1.7 Describe the precedence of alignment of shaft and coupling.

2. Understand the principles of bearings and journals.

- 2.1 Define bearing.
- 2.2 Identify the different types of bearing with their uses.
- 2.3 Identify the materials used in manufacturing of bearing.
- 2.4 Describe the characteristics of a good bearing materials and a good bearing.
- 2.5 Describe the bearing characteristic number and bearing module.
- 2.6 Describe co-efficient of friction of journal bearing.

3. Understand the concept of plant maintenance.

- 3.1 Define plant maintenance.
- 3.2 Describe the basic principles of maintenance.
- 3.3 Mention different types of plant maintenance work.
- 3.4 Describe the preventive maintenance work of a boiler.
- 3.5 Explain the procedure of routine work and periodical inspection of a boiler.
- 3.6 Describe break down maintenance.
- 3.7 Describe the maintenance work of machines such as lathe machine, milling machine.
- 3.8 Describe the maintenance work of crane, lift, pump and compressor.

4. Understand the methods of assembling and fitting.

- 4.1 Describe the concept of assembling and fitting.
- 4.2 Describe assembling method of fixed joint.
- 4.3 Describe assembling method of keyed and splined joint.
- 4.4 Describe assembling method of gear and worm joint.
- 4.5 Identify the different types of pipe fitting.

- 5. Understand the concept of pipe work.**
 - 5.1 Identify the materials used in manufacturing of pipe.
 - 5.2 Identify different types of pipes with their specification and uses.
 - 5.3 Mention the uses of different types of pipe fitting.
 - 5.4 Define seal and gasket.
 - 5.5 Distinguish between seal and gasket.
 - 5.6 Describe the uses of seal and gasket.
 - 5.7 Explain the methods of corrosion protection of pipe.
 - 5.8 Describe the color code of pipe used in industry.

- 6. Understand lubricants, additives and their uses.**
 - 6.1 Define and classify lubricants.
 - 6.2 List the properties of good lubricant.
 - 6.3 Define and classify additives.
 - 6.4 Describe the function of different types of additives.
 - 6.5 Define grease.
 - 6.6 Indicate the specification of grease.
 - 6.7 Point out the application field of grease.
 - 6.8 Identify lubricants used in bearing.
 - 6.9 Describe the characteristics of good lubricants used in bearing.

- 7. Understand the boiler for effective and economic steam generation.**
 - 7.1 Describe boiler.
 - 7.2 Identify different types of boiler.
 - 7.3 Describe different types of boiler.
 - 7.4 Differentiate water and fire tube boiler.
 - 7.5 State the meaning of boiler accessories and mountings.
 - 7.6 Identify and list the boiler accessories and mountings.
 - 7.7 Describe boiler capacity and specification.
 - 7.8 Explain the necessity of water treatment.
 - 7.9 Mention the advantages of economizer and super heater.
 - 7.10 Describe the uses of steam.

- 8. Understand the use of different types of steam turbines.**
 - 8.1 State the meaning of steam turbine.
 - 8.2 Identify the different types of steam turbine.
 - 8.3 Describe the principle of impulse and reaction turbine.
 - 8.4 Describe the procedure of operation of turbine.

- 9. Understand the use of different types of gas turbines.**
 - 9.1 State the meaning of gas turbine.
 - 9.2 Identify the different types of gas turbine.
 - 9.3 Describe the operation of closed cycle constant pressure and constant volume combustion gas turbine.
 - 9.4 Mention the uses of gas turbine.

- 10. Understand the industrial faults and its causes.**
 - 10.1 Describe the industrial faults.
 - 10.2 Identify the different types of faults.

- 10.3 Outline the causes of faults.
- 10.4 Describe the techniques of finding faults.
- 10.5 Mention the safety and controlling devices of electric supply.

11. Understand ventilation and air conditioning system.

- 11.1 Define ventilation and air conditioning system.
- 11.2 Classify Ventilation system.
- 11.3 Describe Ventilation system and control.
- 11.4 Explain legislation and codes of practice after installation.
- 11.5 Classify air condition system.
- 11.6 Describe selection criteria for air conditioning system.
- 11.7 Explain Heating and cooling load calculation.
- 11.8 Describe air conditioning system.
- 11.9 Solve problem related to air condition.

PRACTICAL:

1. Draw installation diagram of a specific machine of a plant.

- 1.1 Collect drawing paper & instruments.
- 1.2 Set the drawing paper on the drawing table or drawing board.
- 1.3 Select drawing area by draw border line.
- 1.4 Draw an installation block diagram according to sequence.
- 1.5 Indicate different part of block diagram with name & number.

2. Check the level of installed machinery in your shop by using spirit level.

- 2.1 Collect leveling instrument (spirit level).
- 2.2 Identify specific machine (lathe, milling, grinding machine etc.)
- 2.3 Set the spirit level on the bed of specific machine.
- 2.4 Observe level and record data from spirit level.
- 2.5 Prepare report and submit.

3. Check the alignment of machine tools.

- 3.1 Collect alignment test instrument (dial indicator).
- 3.2 Identify specific machine (lathe, milling, grinding machine etc.)
- 3.3 Set the dial indicator on the part of specific machine.
- 3.4 Observe alignment and record data from dial indicator.
- 3.5 Prepare report and submit.

4. Identify the basic requirement of installation of a particular machine from its installation diagram.

- 4.1 Collect installation diagram of a specific machine.
- 4.2 Read the diagram carefully and identify its requirements for installation.
- 4.3 Observe machine size, weight and vibration of specific machine.
- 4.4 Note down installation requirement.
- 4.5 Prepare report and submit.

5. Check and find the faulty bearing of old machine, pump, motor, fan, etc in your workshop.

- 5.1 Collect checking tools & equipment for a specific machine.
- 5.2 Identify faulty bearing by diagnosis of its vibration, noise, speed etc. in running condition.

5.3 Observe and note down the condition of faulty bearing of specific machine.

5.4 Prepare report and submit.

6. Replace the faulty bearing with new one of a specific machine, pump, motor, fan, etc in your workshop.

6.1 Collect tools & equipment for replace a bearing of specific machine.

6.2 Open the machine body and casing of identified faulty bearing.

6.3 Replace faulty bearing with new one.

6.4 Cover the machine body and casing of replaced bearing by tightening nut bolt.

6.5 Prepare report and submit.

7. Make Temporary fluid tight pipe joints with specified pipe and pipe fittings.

7.1 Collect pipe fittings, tools & equipment for fluid tight pipe joints.

7.2 Threading the end of the pipe.

7.3 Taping by thread tape on threaded end of pipe.

7.4 Set the fittings by tightening pipe wrench.

7.5 Prepare report and submit.

8. Make permanent fluid tight joint with copper tube and fitting.

8.1 Collect copper tube fittings, tools & equipment for fluid tight pipe joints.

8.2 Threading the end of the pipe.

8.3 Taping by thread tape on threaded end of pipe.

8.4 Set the fittings by tightening pipe wrench.

8.5 Make brazing joint at every fittings.

9. Prepare report and submit

9. Make different types of gaskets with rubber, leather, fiber, copper sheets etc. for different types of flanges, engine head etc.

10. Demonstrate steam boiler.

11. Run the steam engine with the help of the steam from the boiler.

12. Run the turbine coupled generator to generate electricity.

13. Demonstrate Air-conditioning system.

REFERENCE BOOKS :

1. Plant Engineering and Maintenance – R. K. Jain/R. S. Khurmi.

2. Production Technology – R. K. Jain.

3. Hand book of heating ventilation and air conditioning- Jan F. kreider

4. Refrigeration & Air-conditioning P. L Ballaney.

AIMS

- To be able to understand the basic concepts & principles of simple stresses, Strains, principal stresses and strains, thermal stress & strain energy.
- To be able to understand the basic principles and techniques of drawing stress-strain, shear force & bending moment and stress diagram of different materials for different types of loads at different sections.
- To be able to understand the basic concepts and principles of properties of materials and appreciate the techniques of handling the testing machines for testing the mechanical properties of materials.

SHORT DESCRIPTION

Simple stress and strain; Principal stress; Strain energy; Thermal stresses & strain; Shear force and bending moment; Bending stress in beams; Shear stress in beams; Deflection of beam; Torsion; Riveted joint; Welded joint; Properties of materials; Testing of mechanical properties; Column & strut.

DETAIL DESCRIPTION**Theory:**

- 1. Understand simple stresses and strains.**
 - 1.1. Define stress and strain.
 - 1.2. Name different types of stresses and strain.
 - 1.3. Explain modulus of elasticity, modulus of rigidity, Hook's law, bulk modulus and distinguish their relation.
 - 1.4. Express Poisson's ratio.
 - 1.5. Explain the stresses in composite bars.
 - 1.6. Solve problems related to stress and strain.
- 2. Understand the principal stresses and maximum tangential stress.**
 - 2.1. Define principal stresses.
 - 2.2. Define principal plane
 - 2.3. Explain the methods for determination of principal stresses and tangential stress.
 - 2.4. Solve problems related to principal stress.
- 3. Understand the thermal stresses and strains.**
 - 3.1. Define thermal stresses and strains.
 - 3.2. Explain the method of thermal stresses in simple bars, circular tapering section and bars of varying section.
 - 3.3. Explain thermal stresses in composite bar.
 - 3.4. Superposition of thermal stresses.
 - 3.5. Solve problems related to thermal stresses.
- 4. Understand the strain energy and impact loading.**
 - 4.1. Define strain energy impact loading.
 - 4.2. Identify types of loading.
 - 4.3. Define resilience, proof resilience and modulus of resilience.

- 4.4. Explain strain energy stored stress in a body (loading is gradually, suddenly impact).
- 4.5. Solve problems related to strain energy.
- 5. Understand the analysis of the effects of loading on beam.**
 - 5.1. Define beams and classify it.
 - 5.2. Distinguish between statically determinate and statically indeterminate beams.
 - 5.3. Define bending moment and shear force.
 - 5.4. Identify positive sign and negative sign of bending moment and shear force.
 - 5.5. Express the relation between bending moment and shear force.
 - 5.6. Define deformed sections, inflection point and locate their positions.
 - 5.7. Draw shear force diagram and bending moment diagram of beams.
 - 5.8. Solve problems related to beam.
- 6. Understand the analysis of bending stresses in beams.**
 - 6.1. State the theory of simple bending.
 - 6.2. Explain bending stresses.
 - 6.3. Identify position of neutral axis.
 - 6.4. Define moment of resistance.
 - 6.5. Define section modulus.
 - 6.6. Solve problems related to bending stresses in beam.
- 7. Understand the plastic theory of bending.**
 - 7.1. Bending beyond the yield stress.
 - 7.2. Define plastic theory.
 - 7.3. Moment of resistance at a plastic hinge
 - 7.4. Collapse loads
 - 7.5. Combined bending and direct stress
 - 7.6. Portal frames collapse loads
 - 7.7. Solve problems related to plastic theory of bending.
- 8. Understand the analysis of shear stress in beams.**
 - 8.1. Explain shear stress at a section of beam.
 - 8.2. Express the deduction of the formula for shear stress.
 - 8.3. Identify the distribution of shear stress across the section.
 - 8.4. Calculate shear stress in rectangular, triangular, circular and simple composite sections.
 - 8.5. Solve problems related to shear stress.
- 9. Understand deflection of beams.**
 - 9.1. Explain the slope and deflection of a beam.
 - 9.2. Define methods of finding slope and deflection of beam.
 - 9.3. Determine slope and deflection of simple and cantilever beams.
 - 9.4. Solve problems.
- 10. Understand the effects of torsion of solid and hollow shafts.**
 - 10.1. Explain torsion, torsion shear, resisting torque & couple of forces.
 - 10.2. Define polar moment of inertia.
 - 10.3. Derive formula for moment of inertia of solid & hollow shafts.
 - 10.4. Explain strength of solid hollow shafts.
 - 10.5. Express the deduction of formula for torque and angle of twist of solid & hollow shafts.
 - 10.6. Solve problems related to solid and hollow shaft.

11. Understand the design of riveted joints.

- 11.1. Explain riveted joint.
- 11.2. Classify riveted joints.
- 11.3. Explain methods of failures of riveted joints.
- 11.4. Describe strength equation for lap & butt joint.
- 11.5. Determine the efficiency of butt joint.
- 11.6. Determine the efficiency of butt joints (e.g. double and triple riveted joint with equal & unequal pitch & cover plate).
- 11.7. Solve problems related to riveted joint.

12. Understand the welded joints.

- 12.1. Find different dimensions of welded joints.
- 12.2. Identify the advantages and disadvantages of welded joints.
- 12.3. Define strength equation of axially loaded and eccentrically loaded welded joints.
- 12.4. Solve problems related to welded joint.

13. Understand columns and struts.

- 13.1. Define column and strut.
- 13.2. Classify columns and struts.
- 13.3. Define slenderness ratio.
- 13.4. Explain end conditions of column.
- 13.5. State Euler's column theory.
- 13.6. Express the deduction of the formula for failures of column and equivalent length of column.
- 13.7. Express the deduction of the Ranking formula for columns.
- 13.8. Solve problems related to columns and struts.

14. Understand the properties of materials.

- 14.1. Mention the properties of materials.
- 14.2. Define different mechanical properties.
- 14.3. Describe the terms: proportional limit, yield point, ultimate strength & breaking strength.
- 14.4. Draw stress-strain diagram of mild steel bar.

15. Understand the test of mechanical properties of metals.

- 15.1. Define destructive test.
- 15.2. Discuss standard test specimen for tension test of bars, sheets, Brinell Hardness test, Rockwell Hardness test, Izod and Charpy Impact tests.
- 15.3. Identify machines for destructive tests.
- 15.4. Explain the working principle of testing machines (Universal Testing machine, Brinell and Rockwell hardness testing machines, impact testing machines).
- 15.5. Describe the following tests on mild steel specimen: Tensile, compression, shear, hardness, impact and bend.

PRACTICAL:**1. Perform tension test on MS rod.**

- 1.1 Collect the specimen.
- 1.2 Mark the gauge length of specimen.
- 1.3 Set/Clamp the specimen to the machine.
- 1.4 Apply load.
- 1.5 Observe and record data (Yield load, Ultimate load, Breaking load & elongation).

1.6 Calculate stress and strain, percentage of elongation.

1.7 Draw stress-strain curve.

1.8 Remove the tested specimen and make the machine for further use.

1.9 Prepare report and submit.

2. Perform ultimate shear strength test by single shear test.

2.1 Collect the specimen.

2.2 Set the specimen & shear tool to the machine.

2.3 Apply load.

2.4 Observe and record data (Ultimate shear load).

2.5 Remove the tested specimen and make the machine for further use.

2.6 Calculate Shear stress.

2.7 Prepare report and submit.

3. Perform ultimate shear strength test by double shear test.

3.1 Collect the specimen.

3.2 Set the specimen & shear tool to the machine.

3.3 Apply load.

3.4 Observe and record data (Ultimate shear load).

3.5 Remove the tested specimen and make the machine for further use.

3.6 Calculate Shear stress.

3.7 Prepare report and submit.

4. Perform compressive strength test of wood, brick and concrete cylinder specimen.

4.1 Collect the specimen.

4.2 Set the specimen to the machine.

4.3 Apply load.

4.4 Observe and record data (Yield and Ultimate Compressive load).

4.5 Remove the tested specimen and make the machine for further use.

4.6 Calculate Compressive stress.

4.7 Prepare report and submit.

5. Perform bend test of mild steel specimen.

5.1 Collect the specimen.

5.2 Set the specimen to the machine.

5.3 Apply load due to 90° or 120° bend & as required.

5.4 Observe and record data (Ultimate Bending load).

5.5 Remove the tested specimen and make the machine for further use.

5.6 Calculate Bending stress, Modulus of elasticity.

5.7 Physically check and identify any crack or fracture in the bending point.

5.8 Prepare and submit report.

6. Perform the BHN (Brinell Hardness Number) test of Brass, Copper alloy, Aluminum alloy and mild steel specimens.

6.1 Collect the specimen & select indenter.

6.2 Set the specimen & indenter to the machine.

6.3 Apply load according to the metal.

6.4 Observe and record data (Load, dia of indenter & indentation).

6.5 Remove the tested specimen and make the machine for further use.

6.6 Calculate & compare Brinell Hardness Number to standards material & as required.

6.7 Prepare and submit report.

7. Perform the RHN (Rockwell Hardness Number) test of mild steel, Cast Iron, and High carbon steel specimens.

- 7.1 Collect the specimen & select indenter.
- 7.2 Set the specimen & indenter to the machine.
- 7.3 Apply load according to the metal.
- 7.4 Remove load
- 7.5 Observe and record data (RHN from C scale).
- 7.6 Remove the tested specimen and make the machine for further use.
- 7.7 Compare Rockwell Hardness Number to standards material & as required.
- 7.8 Prepare report and submit.

8. Perform torsion test of mild steel specimen.

- 8.1 Collect the specimen.
- 8.2 Set the specimen to the torsion test apparatus.
- 8.3 Apply torsion load.
- 8.4 Observe and record data (Torsion shear load).
- 8.5 Remove the tested specimen and make the apparatus for further use.
- 8.6 Calculate torsion shear strength, modulus of rigidity.
- 8.7 Prepare and submit report.

9. Perform IZOD impact test of mild steel specimen.

- 9.1 Collect the specimen.
- 9.2 Fix the izod striker/hammer in its respective position and place the izod test specimen on supports.
- 9.3 Lift the pendulum till it gets latched in its position at 90° from its vertical axis.
- 9.4 Allow the pendulum to swing freely and break the specimen
- 9.5 Observe and record data (Izod impact energy).
- 9.6 Remove the tested specimen and make the apparatus for further use.
- 9.7 Calculate impact strength.
- 9.8 Prepare and submit report.

10. Perform Charpy impact test of mild steel specimen.

- 10.1 Collect the specimen.
- 10.2 Fix the charpy striker in its respective position and place the charpy test specimen on supports.
- 10.3 Lift the pendulum till it gets latched in its position at 90° from its vertical axis.
- 10.4 Allow the pendulum to swing freely and break the specimen
- 10.5 Observe and record data (Charpy impact energy).
- 10.6 Remove the tested specimen and make the apparatus for further use.
- 10.7 Calculate impact strength.
- 10.8 Prepare and submit report.

11. Perform tension test on Plastic materials.

- 11.1 Collect the specimen.
- 11.2 Mark the gauge length of specimen.
- 11.3 Set/Clamp the specimen to the machine.
- 11.4 Apply load.
- 11.5 Observe and record data (Yield load, Ultimate load, Breaking load & elongation).
- 11.6 Calculate stress and strain, percentage of elongation.
- 11.7 Draw stress-strain curve.
- 11.8 Remove the tested specimen and make the machine for further use.
- 11.9 Prepare report and submit.

REFERENCE BOOKS

- 1 Strength of Materials – R. S. Khurmi
- 2 Strength of Materials – R. K. Jain
- 3 Strength of Materials – V. Singar
- 4 Strength of Materials – G.H. Ryder

AIMS

- To be able to understand the concepts, principles and techniques of various welding such as TIG welding, MIG welding, under water welding, plasma arc, friction, laser beam, ultrasonic, diffusion & explosion welding, different technique used in different types of metal,welding robots and estimation of welding costs.
- To be able to practice welding of various metals, such as steel, alloy steels and non-ferrous metals
- To be able to understand &cut metal by various thermal cutting method such as plasma arc, gas tungsten arc, laser beam, oxy-lance, oxyfuel, under water, oxy arc under water, chemical flux & cutting technic.
- To be able to perform different welding method.

SHORT DESCRIPTION

Scope and importance of TIG & MIG welding; Safety rules; Resistant welding; Principles of underwater weldingprocess; Principle of plasma arc, friction, laser beam, ultrasonic, diffusion & explosion welding ,Various metal cutting process ,welding robots and estimation of welding costs.

DETAIL DESCRIPTION**Theory:****1. Understand the TIG welding.**

- 1.1 Identify TIG welding machines and equipment.
- 1.2 Classify the TIG welding electrodes.
- 1.3 State the principle of TIG welding and its application.
- 1.4 Describe the sequences of operation of TIG welding.
- 1.5 Mention the importance of cleaning and preparation ofTIG welding joints.
- 1.6 Advantages & disadvantages of TIG over ordinary arc welding.
- 1.7 State GTAW and K-TIG.
- 1.8 List the shielding gases used in TIG welding.
- 1.9 Describe the safety to be taken for TIG welding.

2. Understand the MIG welding.

- 2.1 Identify MIG welding machines and equipment.
- 2.2 State the principle of MIG welding and its application.
- 2.3 State SMAW,GMAW,FCAW.
- 2.4 Describe the power supply system in MIG welding.
- 2.5 Describe the wire feed mechanism in MIG welding.
- 2.6 List the shielding gases used in MIG welding.
- 2.7 State the functions of the MIG welding gun.
- 2.8 Describe the techniques of MIG welding process.
- 2.9 Describe the specific advantages & disadvantages of MIG welding.

- 3. Understand the techniques of underwater welding.**
 - 3.1 Define under water welding.
 - 3.2 Mention the equipment used under water welding.
 - 3.3 Describe the operational techniques of underwater welding.
 - 3.4 Importance of underwater welding.
 - 3.5 Discuss the safety needed for under water welding.
- 4. Understand basic concept of laser beam welding.**
 - 4.1 State principle and applications of laser beam welding.
 - 4.2 Describe the special advantages of laser beam welding.
 - 4.3 State the theory of laser beam.
 - 4.4 Describe laser beam welding processes.
 - 4.5 Mention the limitation of laser beam welding.
- 5. Understand the Concept of Ultrasonic welding.**
 - 5.1 State the principle of ultrasonic welding.
 - 5.2 Identify machines and equipment used in ultrasonic welding.
 - 5.3 Describe the operational sequence of ultrasonic welding.
 - 5.4 State application and limitation of ultrasonic welding.
 - 6.5 Mention safety precautions of ultrasonic welding.
- 6. Understand the concept of friction welding.**
 - 6.1 Define friction and inertia welding.
 - 6.2 State the principle of friction welding.
 - 6.3 Identify machines and equipment used in friction welding.
 - 6.4 Describe operational steps in friction welding.
 - 6.5 State application and limitation of friction welding.
 - 6.6 Mention safety precautions of friction welding.
- 7. Understand the concept of plasma arc welding.**
 - 7.1 Define plasma arc welding.
 - 7.2 Identify machines and equipment used in plasma arc welding.
 - 7.3 Describe plasma arc welding processes.
 - 7.4 State application and limitation of plasma arc welding.
 - 7.5 Mention safety needed in plasma arc welding.
- 8. Understand diffusion and explosive welding.**
 - 8.1 Define the diffusion and explosive welding.
 - 8.2 Describe diffusion welding methods.
 - 8.3 State advantages and limitation of diffusion welding.
 - 8.4 Describe mechanism of explosive welding.
 - 8.5 Explain advantages and limitation of explosive welding.
 - 8.6 State application of diffusion and explosive welding.
- 9. Understand welding technique used in different types of metal.**
 - 9.1 Define weld ability, pre-heating and post heating.
 - 9.2 Describe welding processes used for Wrought iron.
 - 9.3 State welding processes used for Cast iron.
 - 9.4 Explain welding processes used for Alloy steel.
 - 9.5 Describe welding processes used for Stainless steel.
 - 9.6 Describe welding processes used for Tool steel.
 - 9.7 Explain welding processes used for Aluminum and its alloy

10. Understand thermal cutting of metals.

- 10.1 Describe plasma arc cutting processes.
- 10.2 Explain laser beam cutting.
- 10.3 State Oxygen lance cutting.
- 10.4 Describe tungsten arc cutting.
- 10.5 State principle of operation of chemical flux cutting.
- 10.6 Discuss physical and metallurgical effects of cutting processes.

11. Understand welding robots.

- 11.1 Define welding robots.
- 11.2 Explain advantage of using welding robot.
- 11.3 Describe schematic of robotic welding system.
- 11.4 Discuss Important factor consider for using welding robot.

12. Understand Estimation of welding Costs.

- 12.1 State objectives of estimating welding costs.
- 12.2 Identify main components costs of welding processes.
- 12.3 Explain factor involved in welding costs.
- 12.4 Describe basic costing procedure of welding.

PRACTICAL

1. Perform the straight bead welding in flat position by TIG welding.

- 1.1 Identify TIG welding machine, tools, equipments and accessories.
- 1.2 Prepare the work piece.
- 1.3 Select& hold the electrode.
- 1.4 Regulate the gas pressure and gas flow.
- 1.5 Set control unit.
- 1.6 Perform weld the straight bead without filler rod.
- 1.7 Performweld the bead with filler rod.
- 1.8 Check the weld.
- 1.9 Practice PPE & clean job - work place.

2. Performbutjoint of stainless steel platein flat position by TIG welding.

3. Perform fillet/lap joint of aluminum plate in flat position by TIG welding process.

4. Performstainless steel pipe jointin 6 G position by TIG welding.

5. Perform the straight bead in flat position by MIG welding.

- 5.1 Identify MIG welding machine, tools, equipments and accessories.
- 5.2 Prepare the work piece.
- 5.3 Select and set the wire electrode.
- 5.4 Select the control tip.
- 5.5 Adjust the gas pressure.
- 5.6 Select and set the voltage.
- 5.7 Set current and the wire feed speed.
- 5.8 Perform the straight bead&Check the weld.
- 5.9 Practice PPE & clean job - work place.

6. Perform single & double Vee butt joint at flat positionby MIG welding.

7. Perform fillet/lap joint at Flat position by MIG welding.

8. **Perform butt joint of cast iron plates.**
9. **Perform gas tungsten arc cutting.**
 - 9.1 Identify tools and equipment of gas tungsten arc cutting.
 - 9.2 Identify different parts of the equipment.
 - 9.3 Adjust control unit and regulator.
 - 9.4 Set the equipment for cutting operation.
 - 9.5 Perform the operation with PPE and check.
10. **Perform laser beam cutting.**
 - 10.1 Identify tools and equipment of laser beam cutting.
 - 10.2 Identify different parts of the equipment.
 - 10.3 Adjust the equipment for operation.
 - 10.4 Perform the cutting with PPE and check.

REFERENCE BOOKS

1. **Welding Engineering- RL Agarwal & Tahil Manghnani.**
2. **Manufacturing Technology- P N RAO.**
3. **A Text book of welding -O.P. Khanna.**
4. **Welding & Technology – Dr. RS Parmar.**
5. **Modern Welding. -Althouse/Tarnquist/Bowditch.**
6. **Welding Skill and Practice- Giachino/Weeks/Brune.**
-American Technical Society, Edition: third.
7. Learning Materials(TIG & MIG) welding Units-6
- Bangladesh Technical Education Board.
8. Production Technology-R .K Jain

AIMS

- To be able to develop the working condition in the field of industrial or other organization.
- To be able to understand develop the labor management relation in the industrial sector.
- To be able to develop the management techniques in the process of decision making.
- To be able to manage the problems created by trade union.
- To be able to understand Planning
- To be able to perform the marketing.
- To be able to maintain inventory.

Course Outline

Basic concepts of management; Principles of management; Planning, Organization, Scientific management; Span of supervision; Motivation; Personnel management and human relation; Staffing and manpower planning ; Training of staff; Concept of leadership; Concepts and techniques of decision making; Concept of trade union; Inventory control; Economic lot size ; Break even analysis; Trade Union and industrial dispute, Marketing;

1 Basic concepts & principles of management.

- 1.1 Define management and industrial management.
- 1.2 State the objectives of modern management.
- 1.3 Describe the scope and functions of management.
- 1.4 State the principles of management.
- 1.5 State the activity level of industrial management from top personnel to workmen.
- 1.6 Describe the relation among administration, organization & management.

2. Concept of Planning

- 2.1 Define Planning
- 2.2 Discuss the importance of Planning
- 2.3 Discuss the Types of Planning.
- 2.4 Discuss the steps in Planning

3 . Concepts of organization and organization structure.

- 3.1 Define management organization.
- 3.2 State the elements of management organization.
- 3.3 Describe different forms of organization structure.
- 3.4 Distinguish between line organization and line & staff organization.
- 3.5 Distinguish between line organization and functional organization.
- 3.6 Describe the features, advantages and disadvantages of different organization structure.

4. Concept of scientific management.

- 4.1 Define scientific management.
- 4.2 Discuss the basic principles of scientific management.
- 4.3 Explain the different aspects of scientific management.
- 4.4 Discuss the advantages and disadvantages of scientific management.
- 4.5 Describe the difference between scientific management and traditional management.

5. Concept of span of supervision.

- 5.1 Define span of supervision and optimum span of supervision.
- 5.2 Discuss the considering factors of optimum span of supervision.
- 5.3 Discuss advantages and disadvantages of optimum span of supervision.
- 5.4 Define delegation of authority.
- 5.5 Explain the principles of delegation of authority.
- 5.6 Explain the terms: authority, responsibility and duties.

6 . Concept of motivation.

- 6.1 Define motivation.
- 6.2 Discuss the importance of motivation.
- 6.3 Describe financial and non-financial factors of motivation.
- 6.4 **Special Motivational Techniques.**
- 6.5 Discuss the motivation theory of Maslow and Herzberg.
- 6.6 Differentiate between theory-X and theory-Y.

7. Concept of leadership.

- 7.1 Define leadership.
- 7.2 Discuss the importance and necessity of leadership.
- 7.3 Discuss the functions of leadership.
- 7.4 Describe the qualities of a leader.

8. Basic concepts and techniques of decision making.

- 8.1 Define decision making.
- 8.2 Discuss the importance and necessity of decision making.
- 8.3 Discuss different types of decision making .
- 8.4 Describe the steps in decision making.

9 .Concept of personnel management and human relation.

- .9.1 Define personnel management.
- .9.2 Discuss the functions of personnel management.
- 9.3 Define staffing.
- 9.4 Define recruitment and selection of employees.
- 9.5 Describe various sources of recruitment of employees.
- 9.6 Describe the methods of selection of employees.
- 9.7 Define training and orientation of employee.
- 9.8 Discuss the importance and necessity of training.
- 9.9 Discuss the various methods of training of workmen, technicians and executive personnel.

10. Concept of inventory control & Economic lot size

- 10.1 Define inventory.& inventory control.
- 10.2 Describe the function of inventory control.
- 10.3 Define Economic lot size and the Method of determination of economic lot size.
- 10.4 Discuss the effects of over supply and under supply.
- 10.5 Explain the following terms :
 - Bin card or Bin tag.
 - Purchase requisition.
 - Store requisition.
 - Material transfer note.
 - First in first out (FIFO).
 - Last in first out(LIFO).
 - Safety stock
 - Lead time

11. Concept of Break Even Point(BEP)

- 11.1 Define Break Even Point and Break Even Chart.
- 11.2 Describe the method of determination of BEP
- 11.3 Explain the terms :
 - Break even analysis.
 - Fixed cost.
 - Variable cost

12 . Concept of Marketing

- 12.1 Define marketing.
- 12.2 Discuss the function of marketing.
- 12.3 State the objectives of marketing.
- 12.4 Explain the terms :
 - Purchase
 - Brand
 - Producer
 - Consumer
 - Customer
 - Copyright
 - Trade mark
- 12.5 Discuss product life -cycle and marketing strategies in different stages of a product life-cycle

13. Concept of trade union and industrial dispute

13.1 Define trade union.

13.2 Mention the objectives of trade union.

13.3 Discuss the function of trade union.

13.4 Describe different types of trade union.

13.5 Define industrial dispute

13.6 Discuss different type of industrial dispute

REFERENCE BOOKS

1. Dr. Md. Mainul Islam and Dr. Abdul Awal Khan-Principles of Management, Bangladesh Open University. 2. Mohammad Mohiuddin-Personnel Management and Industrial Relation, NIDS Publication Co. Dhaka. 3. সুফিয়া বেগম, মো: জাহেদুল হক ও সুপ্রিয়া ভট্টাচার্য্য-ব্যবস্থাপনা এর মৌলিক ধারণা, ব্যতিক্রম প্রকাশনী ঢাকা। Matz Usry-Cost Accounting: Planning & Control.