SRM VALLIAMMAI ENGINEERING COLLEGE
(Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

III SEMESTER

1909307– APPLIED FLUID DYNAMICS AND THERMO DYNAMICS

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Prepared by

Ms.N.Nithya, Asst. Professor (Sr.G.) – Mechanical Engineering

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SUBJECT : 1909307– APPLIED FLUID DYNAMICS AND THERMO DYNAMICS

SEM / YEAR: III Semester / II Year EIE

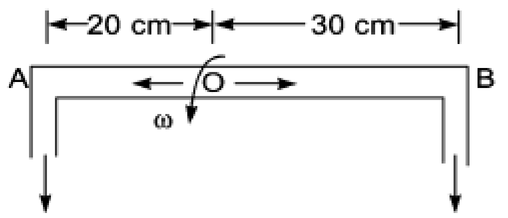
UNIT I - BASIC CONCEPT OF FLUID MECHANICS & FLOW OF FLUIDS			
Introduction – classification - types of fluids – properties - laws of pressure - atmospheric, gauge, absolute pressure, pressure measurement – manometers - mechanical gauges. Head of a liquid - Bernoulli's theorem - orifice and venturi meter.			
PART A			
Q No	**Questions**	**BT Level**	**Competence**
1.	What is specific gravity?	**1**	Remember
2.	Draw the shear stress-velocity gradient profile for Newtonian fluids.	**3**	Apply
3.	What is the effect of cavitation?	**2**	Understand
4.	Justify the use of control volume.	**5**	Evaluate
5.	What is meant by vapor pressure of a fluid?	**3**	Apply
6.	Define surface tension and capillarity	**1**	Remember
7.	When is a fluid considered steady and when it is unsteady?	**1**	Remember
8.	Identify absolute pressure in terms of gauge pressure, atmospheric pressure and vacuum pressure.	**1**	Remember
9.	Where inverted U – tube differential manometer is used? Why?	**1**	Remember
10.	Name some examples of Newtonian and Non – Newtonian fluids.	**1**	Remember
11.	Write the mathematical equation for three-dimensional flow (Steady and Unsteady).	**2**	Understand
12.	Differentiate kinematic viscosity with dynamic viscosity.	**2**	Understand
13.	Relate temperature with dynamic viscosity of gases and liquids.	**2**	Understand
14.	Define the term buoyancy.	**1**	Remember

15.		Show different types of mouthpieces.	**3**	Apply
16.		Calculate the diameter of the soap bubble formed when the inside pressure is $5 N/m^2$ above the atmospheric pressure. If surface tension in the soap bubble is 0.0125 N/m.	**4**	Analyze
17.		Relate specific gravity with density.	**2**	Understand
18.		Classify the different types of orifices.	**2**	Understand
19.		Differentiate absolute pressure from gauge pressure.	**2**	Understand
20.		Point out the phenomena responsible for capillary rise or fall.	**1**	Remember
21.		Contrast ideal and real fluids.	**1**	Remember
22.		What is viscosity?	**1**	Remember
23.		Compare uniform flow and non-uniform flow	**2**	Understand
24.		Write the Bernoulli's theorem mathematically.	**2**	Understand
25.		Convert the height of water column into pressure.	**3**	Apply
		PART B		
1.		The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12.5 mm. The upper plate, which moves at 2.5 m/s requires a force of 98.1 N to maintain the speed. Determine Dynamic viscosity of the oil in poise. **(7)** kinematic viscosity of the oil in stoke if the specific gravity of the oil is 0.95. **(6)**	**4**	Analyze
2.	**i)**	Name and explain any four properties of hydraulic fluid. **(8)**	**1**	Remember
	ii)	What is the difference between dynamic viscosity and kinematic viscosity? State their units of measurements. **(5)**	**1**	Remember
3.	**i)**	List out the assumptions made and limitations of Bernoulli's equation. **(7)**	**1**	Remember
	ii)	Calculate the density, specific weight and weight of one litre of petrol of specific gravity 0.7. **(6)**	**4**	Analyze
4.	**i)**	Explain the working principle of any one pressure gauge	**1**	Remember

		with neat sketch. **(8)**		
	ii)	What do you mean by single column manometers? How are they used for the measurements of pressure? **(5)**	**1**	Remember
5.		Classify manometers. Illustrate each type of manometer with neat sketches. **(13)**	**2**	Understand
6.	**i)**	Explain the property viscosity in detail. **(4)**	**1**	Remember
	ii)	A 0.5 m shaft rotates in a sleeve under lubrication with viscosity 5 poise at 200 rpm. Calculate the power lost for a length of 100 mm if the thickness of the oil is 1 mm. **(9)**	**5**	Evaluate
7.	**i)**	Where orifices and mouth pieces are preferred? Discuss. **(4)**	**1**	Remember
	ii)	Formulate Bernoulli's equation for steady flow of an incompressible fluid. **(9)**	**6**	Create
8.	**i)**	A plate 0.025 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 2 N per unit area to maintain this speed. Estimate the fluid viscosity between the plates. **(8)**	**5**	Evaluate
	ii)	How fluids are classified? Explain. **(5)**	**2**	Understand
9.	**i)**	Express Euler's equation of motion for flow along a stream line (with derivation). **(9)**	**2**	Understand
	ii)	What are the assumptions involved in Euler's equation? **(4)**	**2**	Understand
10.		A U- Tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is open to water in the main line, if the difference in level of mercury in the limbs of U tube is 10 cm and the free surface of mercury is in level with the centre of the pipe. If the pressure of water in pipe line is reduced to 9810 N/m^2, Calculate the new difference in the level of mercury. Sketch the arrangements in both cases. **(13)**	**5**	Evaluate
11.	**i)**	Differentiate Venturimeter and Orifice meter. **(5)**	**2**	Understand
	ii)	A horizontal Venturimeter with inlet diameter 200 mm and throat diameter 100 mm is employed to measure the	**4**	Analyze

		flow of water. The reading of the differential manometer connected to the inlet is 180 mm of mercury. If C_d = 0.98, Calculate the rate of flow. **(8)**		
12.	**i)**	Write short notes on Capillarity and surface tension. **(6)**	**1**	Remember
	ii)	The water is flowing through a pipe having diameters 20 cm and 10 cm at section 1 and 2 respectively. The rate of flow through pipe is 35 litres/sec. The section 1 is 6 m above datum and section 2 is 4 m above the datum. If the pressure at section 1 is 39.24 N/cm^2, find the intensity of pressure at section 2. **(7)**	**4**	Analyze
13.	Horizontal pipe carrying water is gradually tapering. At one section the diameter is 150 mm and flow velocity is 1.5 m/s. If the drop in pressure is 1.104 bar at a reduced section, measure the diameter of that section. If the drop is 5 kN/m^2, what will be the diameter? — Neglect losses. **(13)**		**5**	Evaluate
14.	**i)**	Summarize about atmospheric pressure, vacuum pressure and absolute pressure. **(5)**	**2**	Understand
	ii)	Examine the discharge through a tapered drainage pipe of diameters at the inlet and exits are 1000 mm and 500 mm respectively. The water surface is 2 m above the centre of the inlet and exit is 3 m above the free surface of the water. The pressure at the exit is 250 mm of Hg vacuum. The friction loss between the inlet and exit of the pipe is 1/10 of the velocity head at the exit. **(8)**	**3**	Apply
15.	Explain the classification and theory of different types of mechanical gauges for pressure measurement. **(13)**		**1**	Remember
16.	A 300 mm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s. If the axis of the pipe turns through 45^o, find the magnitude and direction of the resultant force at the bend. **(13)**		**5**	Evaluate

17.	A drainage pipe is tapered in a section running with full of water. The pipe diameter of the inlet and exit are 1000 mm and 500 mm respectively. The water surface is 2 m above the centre of the inlet and exit is 3 m above the free surface of the water. The pressure at the exit is 250 mm of Hg vacuum. The friction loss between the inlet and exit of the pipe is1/10 of the velocity head at the exit. Determine the discharge through the pipe. **(13)**	**4**	Analyze
18.	A 45^o reducing bend is connected in a pipe line, the diameters at the inlet and outlet of the bend being 600 mm and 300 mm respectively. Find the force exerted by water on the bend if the intensity of pressure at inlet to bend is 8.829 N/cm^2 and rate of flow of water is 600 liters/s. **(13)**	**4**	Analyze
	PART C		
1.	Write Bernoulli's theorem. Discuss any one application of Bernoulli's theorem in detail. **(15)**	**1**	Remember
2.	A pipe 200 m long slopes down at 1 in 100 and tapers from 600 mm diameter at the higher end to 300 mm diameter at the lower end, and carries 100 litres / sec of oil having specific gravity 0.8. If the pressure gauge at the higher end reads 60 kN/m^2, determine the velocities at the two ends and also the pressure at the lower end. Neglect all losses. **(15)**	**5**	Evaluate
3.	A 30 cm x 15 cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevation of the throat section and entrance section of the venturimeter is 30 cm. The differential U tube mercury manometer shows a gauge deflection of 25 cm. Evaluate: (a) the discharge of oil. (b) The pressure difference between the entrance section and the throat section. Take C_d = 0.98 and specific gravity of mercury as 13.6. **(15)**	**4**	Analyze
4.	Calculate the dynamic viscosity of oil which is used for	**5**	Evaluate

	lubrication between square plate of size 0.8m x 0.8 m and an inclined plane with angle of inclination 30˚. The weight of the square plate is 300 N and it slide down the inclined plane with a uniform velocity of 0.3m/s. The thickness of the oil film is 1.5 mm. **(15)**		
5.	The lawn sprinkler with two nozzles of diameter 4mm each is connected across a tap of water as shown in Fig.1. The nozzles are at a distance of 30 cm and 20 cm from the centre of the tap. The rate of flow of water through tap is 120 cm³/s. The nozzles discharge water in the downward directions. Determine the angular speed at which the sprinkler will rotate free.  Fig. 1	**4**	Analyze
6.	A pipe (1) 450 mm in diameter branches into two pipes (2) and (3) of diameters 300 mm and 200 mm respectively. If the average velocity in 450 mm diameter pipe is 3m/s. Find, (i). Discharge through 450 mm diameter pipe;(ii) Velocity in 200 mm diameter pipe if the average velocity in 300 mm pipe is 2.5 m/s.	**4**	Analyze

UNIT II - DIMENSIONAL ANALYSIS			
Introduction – dimensions - dimensional analyses - Rayleigh's and Buckingham's method.			
PART A			
Q No	**Questions**	**BT Level**	**Competence**
1.	Define fundamental units and derived units with example.	**1**	Remember
2.	Quote Dimensionally Homogeneous equation with an example.	**1**	Remember
3.	Define the term dimensional analysis.	**1**	Remember
4.	Write the dimensions of the following Physical Quantities: (i) Pressure (ii) Surface Tension	**1**	Remember
5.	List out the advantages of Dimensional analysis.	**1**	Remember
6.	What are the methods of dimensional analysis?	**1**	Remember
7.	Describe the Rayleigh's method for dimensional analysis.	**1**	Remember
8.	Summarize the Buckingham's π – theorem.	**2**	Understand
9.	Apply dimensional homogeneity for the equation $v = u + at$.	**3**	Apply
10.	What do you mean by repeating variables?	**1**	Remember
11.	How to calculate the number of π terms while applying Buckingham's π theorem.	**3**	Apply
12.	How are the repeating variables selected for dimensional analysis?	**3**	Apply
13.	Illustrate how the equations are derived in Raleigh's method.	**1**	Remember
14.	What are the significances of Buckingham's π theorem?	**1**	Remember
15.	What are the needs of dimensional analysis?	**1**	Remember
16.	List of physical quantities having the same dimensional formula.	**2**	Understand
17.	What are dimensional constants?	**1**	Remember
18.	Give the dimensions of: i) Force ii) Viscosity.	**1**	Remember
19.	Compare Rayleigh's method with Buckingham's method.	**2**	Understand
20.	Point out the important limitations of dimensional analysis.	**1**	Remember
21.	Give the dimensions of: i) Power ii) Kinematic viscosity.	**2**	Understand
22.	Find the dimensions of: i) Angular velocity ii) Angular acceleration.	**2**	Understand
23.	Determine the dimensions of: i) Discharge ii) Specific weight.	**2**	Understand

24.		Find the dimensions of: i) Surface tension ii) Shear stress.	**2**	Understand
25.		What are the applications of dimensional analysis?	**1**	Remember
		PART B		
1.	**i)**	List the criteria for selecting repeating variable in this dimensional analysis? **(7)**	**1**	Remember
	ii)	Check whether the following equation is dimensionally homogeneous. T = 2π√(L/g). **(6)**	4	Analyze
2.	**i)**	List out the criteria for selecting repeating variable in dimensional analysis. **(7)**	**1**	Remember
	ii)	Write a short note on dimensional homogeneity with suitable examples. **(6)**	**2**	Understand
3.		The pressure difference (ΔP) in a pipe of diameter D and length L, due to viscous flow depends on the velocity V, viscosity μ and density ρ using Buckingham's π – theorem, deduce the expression for ΔP. **(13)**	**4**	Analyze
4.		The resisting force (R) of a supersonic flight can be considered as dependent upon the length of the air craft 'l', velocity 'v', air viscosity 'μ', air density 'ρ' and bulk modulus of air is 'k'. Express the functional relationship between these variables and the resisting force. By using Rayleigh's method. **(13)**	**4**	Analyze
5.		The efficiency (η) of a fan depends on ρ (density), μ (viscosity) of the fluid, ω (angular velocity), d (diameter of rotor) and Q (discharge). Give η in terms of non-dimensional parameters. Use Buckingham's π theorem. **(13)**	**4**	Analyze
6.		Explain the step by step procedure of Buckingham's π – theorem with suitable example. **(13)**	**1**	Remember
7.		Using Buckingham's π- theorem, Develop the expression for velocity through a circular orifice in a pipe as, $v = \sqrt{2gH}\,\phi\left[\frac{D}{H}, \frac{\mu}{\rho V H}\right]$	**4**	Analyze

	where v is the velocity through orifice of diameter d and H is the head causing the flow and ρ and μ are the density and dynamic viscosity of the fluid passing through the orifice and g is acceleration due to gravity. **(13)**		
8.	**i)** Explain the Rayleigh's method of dimensional analysis with an example. **(9)** **ii)** List out the advantages of dimensional analysis. **(4)**	**1** **1**	Remember Remember
9.	The variable controlling the motion of a floating vessel through water are the drag force F, the speed V, the length L, the density ρ and dynamic viscosity μ of water and acceleration due to gravity g. Derive an expression for F by dimensional analysis. **(13)**	**4**	Analyze
10	The drag force exerted by a flowing fluid on a solid body depends upon the length of the body L, velocity of flow V, density of fluid ρ, and viscosity μ. Find an expression for drag force using Buckingham's π theorem. **(13)**	**4**	Analyze
11.	The power developed by hydraulic machines is found to depend on the head H, flow rate Q, density ρ, Speed N, runner diameter D and acceleration due to gravity g. Obtain suitable dimensionless parameters to correlate experimental results. **(13)**	**4**	Analyze
12.	The capillary rise h is found to be influenced by the tube diameter D, density ρ, gravitational acceleration g and surface tension σ, determine the dimensional parameters for the correlation of experimental results. **(13)**	**4**	Analyze
13.	A partially submerged body is towed in water. The resistance R to its motion depends on the density ρ, the viscosity μ of water, length l of the body, velocity v of the body and the acceleration due to gravity g. Express the functional relationship between these variables and resisting force. Using Rayleigh's method. **(13)**	**4**	Analyze
14.	The resisting force(R) of a supersonic flight can be considered as	**5**	Evaluate

	dependent upon the length of the air craft ‘l’, velocity ‘v’, air viscosity ‘μ’, air density ‘ρ’ and bulk modulus of air is ’k’. Express the functional relationship between these variables and the resisting force. Use Buckingham's π theorem. **(13)**		
15.	A partially submerged body is towed in water. The resistance R to its motion depends on the density ρ, the viscosity μ of water, length l of the body, velocity v of the body and the acceleration due to gravity g. Express the functional relationship between these variables and resisting force. Buckingham's π theorem. **(13)**	**5**	Evaluate
16.	The power required by an agitator in a tank is a function of the following variables: a. Diameter of the agitator b. Number of rotations of the impeller per unit time c. Viscosity of liquid d. Density of liquid From dimensional analysis using Buckingham's method, obtain a relation between power and the four variables. **(13)**	**4**	Analyze
17.	The force exerted by a flowing fluid on a stationary body depends upon the length L of a body, velocity V of the fluid, density ρ of fluid, viscosity μ of fluid and acceleration g due to gravity. Find an expression for the force using dimensional analysis. **(13)**	**4**	Analyze
18.	The discharge through an orifice depends on the diameter D of the orifice, head H over the orifice, density ρ of liquid, viscosity μ of liquid acceleration g due to gravity. Using dimensional analysis, find an expression for the discharge. Hence find the dimensionless parameters on which the discharge co-efficient of an orifice meter depend. **(13)**	**4**	Analyze
	PART C		
1.	Using Buckingham's π –theorem, show that the discharge Q consumed by an oil ring is given by, $\boldsymbol{Q} = \boldsymbol{N}\mathrm{d}^3\ \Phi\ [\ \boldsymbol{\mu/\rho N d^2}, \boldsymbol{\sigma/\rho N^2 d^3}, \boldsymbol{\omega/\rho N^2 d}]$ where d is the internal diameter of the ring, N id rotational speed, ρ is density, viscosity μ, σ is surface tension and ω is the specific weight of oil. **(15)**	**6**	Create
2.	The power P developed by a water turbine depends on the rotational speed N, operating head H, gravity g, diameter D and	**5**	Evaluate

	width B of the runner, density ρ and viscosity μ of water. Show by dimensional analysis that, $P = \rho D^5 N^3 \Phi[\frac{H}{D}, \frac{D}{B}, \frac{\rho D^2 N}{\mu}, \frac{ND}{\sqrt{gH}}]$ **(15)**		
3.	Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of the fluid medium which can be denoted by the speed of sound in the medium C. **(15)**	**5**	Evaluate
4.	The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. By using Rayleigh's method. **(15)**	**4**	Analyze
5.	The pressure difference (ΔP) in a pipe of diameter D and length L, due to turbulent flow depends on the velocity V, viscosity μ and density ρ using Buckingham's π – theorem, deduce the expression for ΔP. **(15)**	**4**	Analyze
6.	The resistance R, to the motion of a completely sub-merged body depends upon the length of the body L, velocity of flow V, mass density of fluid ρ and kinematic viscosity of fluid v. By dimensional analysis $R = \rho V^2 L^2 \phi (VL / v)$ **(15)**	**4**	Analyze

UNIT III - PUMPS AND TURBINES			
Introduction - types of pumps - reciprocating pump - construction details - co-efficient of discharge – slip - power required - centrifugal pump – classification - working principle - specific speed – turbines – classification – working principle			
PART A			
Q No	**Questions**	**BT Level**	**Competence**
1.	Define slip of reciprocating pump.	**1**	Remember
2.	Where air-vessels are used? Why?	**2**	Understand
3.	What is suction head of a pump?	**1**	Remember
4.	Define mechanical efficiency of a pump.	**1**	Remember
5.	List out various Roto dynamic pumps.	**1**	Remember
6.	Name the parts of a centrifugal pump.	**1**	Remember
7.	Why actual discharge be greater than theoretical discharge in a reciprocating pump?	**2**	Understand
8.	Where impulse turbine is preferred?	**1**	Remember
9.	Label the parts of single acting reciprocating pump with simple sketch.	**2**	Understand
10.	Differentiate Francis turbine from Kaplan turbine.	**2**	Understand
11.	Discuss briefly about indicator diagram.	**1**	Remember
12.	Define percentage of slip of reciprocating pump.	**1**	Remember
13.	Classify the different types of turbines.	**2**	Understand
14.	Explain specific speed of a turbine.	**1**	Remember
15.	Point out the functions of a draft tube.	**1**	Remember
16.	Compare turbines with pumps.	**2**	Understand
17.	Select the type of turbine for low head power plants and high head power plants.	**1**	Remember
18.	What is an air vessel?	**1**	Remember
19.	Combine the velocity triangles of inlet and outlet of centrifugal pump.	**1**	Remember
20.	Find the expression for the head lost due to friction in suction	**2**	Understand

	and delivery pipe of reciprocating pump.		
21.	Define cavitations.	**1**	Remember
22.	What do you understand by the term Priming?	**2**	Understand
23.	List the parts of double acting reciprocating pump with simple sketch.	**2**	Understand
24.	When does negative slip occur?	**2**	Understand
25.	What are the losses in centrifugal pump?	**1**	Remember
	PART B		
1.	**i)** Describe the working principle of single acting reciprocating pump with neat sketch. **(9)** **ii)** Tabulate the differences between reciprocating pump and centrifugal pump. **(4)**	**1** **1**	Remember Remember
2.	**i)** Define and classify pumps. **(3)** **ii)** Describe the construction and working principle of centrifugal pump with neat sketch. **(10)**	**1** **2**	Remember Understand
3.	**i)** Draw and explain the velocity triangle of centrifugal pump. **(8)** **ii)** Draw and discuss about the performance curves of centrifugal pump. **(5)**	**2** **2**	Understand Understand
4.	Examine the theoretical discharge, coefficient of discharge, slip and the percentage slip of a single acting reciprocating pump running at 50 rpm, delivers 0.01 m^3/s of water. The diameter of the piston is 200 mm and stroke of 400 mm. **(13)**	**5**	Evaluate
5.	The diameter and stroke of a single acting reciprocating pump are 120 mm and 300 mm respectively. The water is lifted by a pump through a total head of 25 m. The diameter and length of delivery pipe are 100 mm and 20 mm respectively. Calculate: **(i)** Theoretical discharge and theoretical power required to run the pump if its speed is 60rpm. **(4)** **(ii)** Percentage slip, if the actual discharge is 2.35 1/s. **(4)** **(iii)** The acceleration head at the beginning and middle of the	**5**	Evaluate

	delivery stroke. **(5)**		
6.	The diameter and length of a suction pipe of a single acting reciprocating pump are 10 cm and 5 m respectively. The pump has a plunger diameter of 15 cm and a stroke length of 35 cm. The center of the pump is 3 m above the water surface in the sump. The atm. Pressure head is 10.3 m of water and the pump runs at 50 rpm. Collect (Find), i)Pressure head due to Acceleration at the beginning of the suction stroke**.** **(4)** ii)Maximum pressure head due to Acceleration. **(4)** iii)Pressure head in the cylinder at the beginning and end of the suction stroke. **(5)**	**4**	Analyze
7.	Give short notes on following i)Indicator diagram of single acting reciprocating pump. **(5)** ii)Priming of pump. **(4)** iii)Specific speed of pump. **(4)**	**1**	Remember
8.	Deduce the expression for the following: i)Specific speed of pump. **(4)** ii)Power required to drive reciprocating pump. **(4)** iii)Coefficient of discharge in reciprocating pump. **(5)**	**2**	Understand
9.	A double acting reciprocating pump running at 60 rpm is discharging 1.5 m^3 of water per minute. The pump has a stroke length of 400 mm. The diameter of the piston is 250 mm. The delivery and suction heads are 20 m and 5 m respectively. Predict (Find) the power required to drive the pump and the slip of the pump. **(13)**	**5**	Evaluate

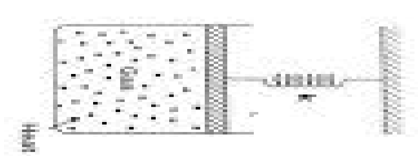
10.	A double acting reciprocating pump has a bore of 150 mm and stroke of 250 mm and runs at 35 rpm. The piston rod diameter is 20 mm. The suction head is 6.5 m and the delivery head is 14.5 m. The discharge of water was 4.7 lit/s. Prepare (Determine) the slip and the power required. **(13)**		4	Analyze
11.	The internal and external diameters of the impeller of centrifugal pumps are 200 mm and 400 mm respectively. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20^o and 30^o respectively. The water enters the impeller radially and velocity of flow is constant. Examine the work done by the impeller per unit weight of water. Sketch the velocity triangle. **(13)**		4	Analyze
12.	**i)**	Discuss about cavitations, its causes, effects and prevention. **(9)**	**2**	Understand
	ii)	Differentiate impulse turbine from reaction turbine. **(4)**	**2**	Understand
13.	**i)**	Summarize the importance of draft tube in hydraulic turbines. **(3)**	2	Understand
	ii)	List the classification of turbines and explain the working of Pelton wheel with neat sketch. **(10)**	1	Remember
14.	**i)**	Explain the construction and working of Francis turbine with neat sketch. **(10)**	**1**	Remember
	ii)	Differentiate Francis turbine from Kaplan turbine. **(3)**	**2**	Understand
15.	Compare and contrast Francis turbine and Pelton wheel with simple sketches. **(13)**		2	Understand
16.	**i)**	Define Specific speed of turbine. **(3)**	**2**	Understand
	ii)	Explain the working principle of Kaplan turbine with neat sketch. **(10)**	**1**	Remember
17.	**i)**	Give short note on air vessels. **(4)**	**2**	Understand
	ii)	Explain the working principle of double acting reciprocating pump with a neat sketch. **(9)**	**2**	Understand

18.		A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 lps under a head of 30 m. The buckets deflect the jet through an angle of 160°. Identify the power given by the water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98. **(13)**	**4**	Analyze
		PART C		
1.	**i)**	IIustrate an inward and an outward flow reaction turbine. **(7)**	**2**	Understand
	ii)	Appraise the significance of specific speed in pumps and turbines. **(8)**	**1**	Remember
2.		The diameter and length of a suction pipe of a single acting reciprocating pump are 10 cm and 5 m respectively. The pump has a plunger diameter of 15 cm and a stroke length of 35 cm. The centre of the pump is 3 m above the water surface in the sump. The atm. Pressure head is 10.3 m of water and the pump runs at 50 rpm. Collect (Find), (i) pressure head due to Acceleration at the beginning of the suction stroke. (ii) Maximum pressure head due to Acceleration and (iii) pressure head in the cylinder at the beginning and end of the suction stroke. **(15)**	**5**	Evaluate
3.	**i)**	A single acting reciprocating pump has a bore of 200 mm and a stroke of 350 mm and runs at 45 rpm. The suction head is 8 m and the delivery head is 20 m. Evaluate the theoretical discharge of water and power required. If slip is 10%, what is the actual flow rate? **(10)**	**5**	Evaluate
	ii)	Explain the term Priming. Why is it necessary? **(5)**	**1**	Remember
4.		Design the construction and working principle of single acting and double reciprocating pump with indicator diagram. **(15)**	**6**	Create
5.		A Pelton turbine is required to develop 9000 kW when working under a head of 300 m the impeller may rotate at 500 rpm. Assuming a jet ratio of 10 and an overall efficiency of 85%	**4**	Analyze

	calculate(i) Quantity of water required, (ii) Diameter of the wheel, (iii) No of jets, (iv) No and size of the bucket vanes on the runner. **(15)**		
6.	A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 r.p.m works against a total head of 40m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50mm, determine: (i) Vane angle at inlet, (ii) Work done by impeller on water per second (iii) Manometric efficiency. **(15)**	**4**	Analyze

UNIT IV - LAWS OF THERMODYNAMICS AND BASIC IC ENGINE CYCLES			
Systems, Zeroth law, first law of thermodynamics - concept of internal energy and enthalpy - applications of closed and open systems - second law of thermodynamics. Basic IC engine, 2 stroke and 4 stroke engine and gas turbine cycle- Brayton cycle.			
PART A			
Q No	**Questions**	**BT Level**	**Competence**
1.	Compare homogeneous and heterogeneous system.	**2**	Understand
2.	Define state, process and cycle.	**1**	Remember
3.	List out the various non – flow processes.	**1**	Remember
4.	Define the term scavenging related with IC engines.	**1**	Remember
5.	Label various parts of four stroke diesel engine with a sketch.	**1**	Remember
6.	Distinguish between open and closed system.	**2**	Understand
7.	Tabulate the differences between two stroke and four stroke petrol engine.	**2**	Understand
8.	Name the different types of I.C engines.	**1**	Remember
9.	Summarize the functions of carburetor in petrol engine.	**2**	Understand
10.	Distinguish Clausius statement with Kelvin Plank statement.	**2**	Understand
11.	Give examples for intensive and extensive properties.	**1**	Remember
12.	State zeroth law of thermodynamics.	**2**	Understand
13.	Express the equations for work done and heat transfer in polytrophic process	**2**	Understand
14.	Compare intensive and extensive properties.	**2**	Understand
15.	Calculate the mass of the air, if the specific heats at constant pressure and volume are 1 kJ/kg K and 0.72 kJ/kg K respectively. The volume of air at a pressure of 5 bar and 47°C is 0.5 m^3	**4**	Analyze
16.	Give the limitations of first law of thermodynamics.	**2**	Understand
17.	Illustrate reversible and irreversible process.	**1**	Remember
18.	State any one Gas law.	**1**	Remember
19.	Prove that for an isolated system, there is no change in internal energy.	**2**	Understand

20.	Indicate any one of process in PV diagram.	**2**	Understand
21.	Prove that the difference in specific heat capacities equal to Cp - Cv = R.	**5**	Evaluate
22.	Compare isothermal process with adiabatic process.	**2**	Understand
23.	Analyze the functions of piston and crankshaft of an I.C engine.	**2**	Understand
24.	What is perpetual motion machine of first kind?	**2**	Understand
25.	Differentiate between point function and path function	**2**	Understand
	PART B		
1.	**i)** Describe the following: a) Enthalpy, b) Entropy **(4)** **ii)** 0.336 m^3 of gas at 10 bar and 150^oC expands adiabatically, until its pressure is 4 bar. It is then compressed, isothermally, to its original volume. Evaluate the final temperature and pressure of the gas. Also evaluate the change in internal energy. Take Cp= 0.996 kJ/kg K; and Cv= 0.703 kJ/kg K. **(9)**	**1** **5**	Remember Evaluate
2.	Derive the expression for work done in the open cycle gas turbine with regeneration and explain the importance of regeneration. **(13)**	**2**	Understand
3.	Explain the working principle of four stroke petrol engine with suitable sketches. And draw the P-V diagram for the four stroke petrol engine. **(13)**	**1**	Remember
4.	Explain the working principle of two stroke petrol engine with suitable sketches. And draw the P-V diagram for the two stroke petrol engine. **(13)**	**1**	Remember
5.	Air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature 200 C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90:1. If the flow rate of air is 3 kg/s, find a) Power developed, b) Thermal efficiency of the cycle. Assume Cp=1 kJ/kg K and γ=1.4 of air and gases calorific	**3**	Apply

	value of fuel=41800kJ/kg. **(13)**		
6.	Examine the efficiency of an open circuit constant pressure gas turbine plant with the following specifications. The extreme value of pressure and temperature in plant are 1 bar, 5.25 bar and 25°C and 560°C respectively. The isentropic efficiency of the turbine is 88% and that of the compressor is 84%. (1**3)**	**3**	Apply
7.	A constant volume gas thermometer containing nitrogen is brought into constant with a system of unknown temperature and then into contact with a system maintained at the triple point of water. The mercury column attached to the device has readings of 59.2 and 2.28 cm respectively for the two systems. If the barometric pressure is 960 m of bar, what is the unknown temperature in kelvin, if g = 9.806 m/sec². Specific gravity of mercury may be taken as 13.6. **(13)**	**4**	Analyze
8.	Evaluate the non-flow work of a gas undergoing a reversible process in terms of p1, V1 and p2 according to the following relationships: i)P = C, i.e. Isobaric ii) V = C, i.e. Isometric iii) T = C, i.e. Isothermal **(13)**	**5**	Evaluate
9.	A gas is at a pressure of 3 bar in a cylinder with frictionless movable piston. Shown in Fig. 1. The spring force exerted through the piston is proportional to the volume of gas. Also an additional atmospheric pressure of 1 bar acts on the spring side of piston, Determine the work done by gas in expansion from 0.1 m³ to 0.5 m³.  Fig. 1 ° **(13)**	**4**	Analyze

10.	**i)** Explain the working of gas turbine plant with the help of Brayton cycle. **(6)** **ii)** Express by deriving, the air standard efficiency of a Brayton cycle in terms of pressure ratio and compression ratio. **(7)**		**4** **2**	Analyze Understand
11.	**i)** Explain the working principle of four stroke diesel engine. **(8)** **ii)** Illustrate Diesel cycle and Dual cycle with the help of P–V and T–S diagram. **(5)**		**4** **3**	Analyze Apply
12.	In a constant pressure open cycle gas turbine air enters at 1 bar and 200°C and leaves the compressor at 5 bar. Using the following data: Temperature of the gas entering the turbine = 680°C, the pressure loss in the compression chamber =0.1 bar, η compressor = 85%, η turbine = 80%, η combustion = 85%, γ=1.4, Cp=1.024 kJ/kg K for air and gas, find a) The quantity of air circulation if the plants develop 1065 kW b) Heat supplied per kg of air circulation c) The thermal efficiency if the cycle, mass of the fuel may be neglected. **(13)**		**2**	Understand
13.	**i)** Describe the following: i) PMM2 and ii) First Law of thermodynamics. **(6)** **ii)** State and explain the corollaries of second law of thermodynamics. **(7)**		**1** **4**	Remember Analyze
14.	Evaluate the total work done and the pressure, volume and temperature at all the points for the following sequence of processes of a system. It exists with 0.2 m^3 of a gas at 4 bar and 425 K. If it is expanded adiabatically to 1 bar. The gas is then heated at constant pressure till the enthalpy increases by 70 KJ. Sketch the process on PV plot. **(13)**		**5**	Evaluate
15.	The pressure ratio of an open cycle gas turbine power plant is 5.6. Air taken as 30^0C and 1 bar. The compression is carried out in two stages with perfect inter cooling in between. The maximum temperature of the cycle is limited to 700^0C.		**4**	Analyze

	Assuming the isentropic efficiency of each compressor stage as 85% and that of turbine as 90%, determine the power developed and efficiency of the power plant, if the air flow is 1.2 kg/s. The mass of fuel may be neglected, and it may be assumed that Cp = 1.02 kJ/kg K and γ = 1.41. **(13)**		
16.	A gas turbine unit receives air at 1 bar and 300K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and the fuel air ratio is 0.017. Take turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. For product of combustion, cp =1.147kJ/kg K and γ=1.333. **(13)**	**5**	Evaluate
17.	Tabulate the differences between four stroke and two stroke engines and also tabulate the differences between petrol and diesel engines. **(13)**	**1**	Remember
18.	Briefly explain about the working of heat engine and derive the expression of thermal efficiency of it. **(13)**	**2**	Understand
	PART C		
1.	Construct the working of gas turbine power plant and its cycle with neat sketch. **(15)**	**6**	Create
2.	An imaginary engine receives heat and does work on a slowly moving piston at such rate that the cycle of operation of 1 kg of working fluid can be represented as a circle 10 cm in diameter on a p-v diagram on which 1 cm = 300 kPa and 1 cm = 0.1 m^3/kg. 1. how much work is done by each kg of working fluid for each cycle of operation? 2. the thermal efficiency of an engine is defined as the ratio of work done and heat input in a cycle. If the heat rejected by the engine in a cycle is 1000 kJ per kg of working fluid, what would be its thermal efficiency? **(15)**	**5**	Evaluate
3.	Collaborate the list of engine parts, material to be used and method of manufacture and its functions. **(15)**	**6**	Create

4.	A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610°C. The isentropic efficiencies of compressor and turbine are 80% and 82% respectively. Calculate the power output in KW of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16 kg/s. Take Cp=1.005 kJ/kg K and γ=1.4 for the compression process, and take Cp=1.11kJ/kg K and γ=1.333 for the expansion process.**(15)**	**5**	Evaluate
5.	Apply the first law of thermodynamics in human bodies, I.C engines and also compare with them. **(15)**	**3**	Apply
6.	A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation u = l.5 pv – 85 kJ/kg Where p is in kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. **(15)**	**4**	Analyze

UNIT V - THERMODYNAMICS OF REFRIGERATORS AND HEAT PUMPS			
Properties of steam - Rankine cycle - Boilers and its accessories - Basic thermodynamics of refrigerators and heat pumps.			
PART A			
Q No	**Questions**	**BT Level**	**Competence**
1.	Give the possible ways to increase thermal efficiency of Rankine cycle.	**1**	Remember
2.	Name the different components in steam power plant working on Rankine cycle.	**1**	Remember
3.	List out boiler mountings and accessories.	**1**	Remember
4.	Define boiler. How it is classified?	**1**	Remember
5.	Tabulate the differences between mountings and accessories of boiler.	**2**	Understand
6.	When the steam is called as saturated and when it is called super-heated?	**1**	Remember
7.	Define the terms sensible heat and latent heat of vaporization of water.	**1**	Remember
8.	Write a short note on Mollier Chart.	**1**	Remember
9.	Define pure substance.	**1**	Remember
10.	What is the purpose of condenser in steam power plant?	**1**	Remember
11.	Identify the thermodynamic definitions of heat pump and refrigerator.	**1**	Remember
12.	Express the term dryness fraction.	**2**	Understand
13.	Differentiate between refrigeration & air conditioning.	**2**	Understand
14.	Estimate the volume occupied by 5 kg of dry saturated steam at 10 bar.	**5**	Evaluate
15.	Discuss latent heat of vaporization.	**1**	Remember
16.	State the limitations of first law of thermodynamics.	**2**	Remember
17.	List the suitable example for reversible and irreversible process.	**1**	Remember
18.	What is the function of steam superheater?	**2**	Understand

19.	Illustrate the Rankine cycle with the help of p – V diagram.		**1**	Remember
20.	Compare source and sink thermodynamically.		**2**	Understand
21.	Measure the Entropy of the wet steam with dryness fraction of 0.8 at 10 bar.		**4**	Analyze
22.	Point out the working of heat engine with the help of block diagram.		**1**	Remember
23.	Explain the effect of reheating in Rankine cycle.		**1**	Remember
24.	Recommend the parts required to improve the efficiency of a steam power plant.		**2**	Understand
25.	Modify heat pump into refrigerator with the help of block diagram.		**4**	Analyze
		PART B		
1.		Find the enthalpy, internal energy and entropy of 1 kg of steam at a pressure of 10 bar i) when steam is dry saturated, ii) when steam is 0.75 dry and iii) when steam is superheated to 250°C. Use steam tables and neglect volume of water.	**4**	Analyze
2.	**i)**	Describe the construction and working of a Water tube boiler with neat sketch. **(9)**	**1**	Remember
	ii)	Classify boilers with examples. **(4)**	**1**	Remember
3.	**i)**	Describe the characteristics of high-pressure boilers. **(4)**	**1**	Remember
	ii)	Explain the construction and working of any one high pressure boiler with neat sketch. **(9)**	**1**	Remember
4.	The steam conditions at inlet to the turbine are 42 bar and 500˚C, and the condenser pressure is 0.035bar. Assume that the steam is just dry saturated on leaving the first turbine, and is reheated to its initial temperature. Calculated the Rankine cycle efficiency and specific steam consumption with reheating by neglecting the pump work using Mollier chart.		**4**	Analyze
5.	A steam power plant operates on a theoretical reheat cycle. Steam at 25 bar pressure and 400○C is supplied to a high		**4**	Anayze

	pressure turbine. After its expansion to dry state the steam is reheated to a constant pressure to its original temperature. Subsequent expansion occurs in the low pressure turbine to a condenser pressure of 0.04 bar. Considering feed pump work, make calculation to determine (i) quality of steam at the entry to the condenser (ii) thermal efficiency (iii) Specific steam consumption.		
6.	Illustrate the Rankine cycle with p – V and h – S diagram and derive the efficiency of steam power plant. **(13)**	**3**	Apply
7.	One kg of steam at 10 bar exists at the following conditions: Wet and 0.8 dry, dry and saturated and at a temperature of 199.9^{0}C. Interpret the data using steam tables and find the enthalpy, specific volume, density, internal energy and entropy at each case. Take specific heat of super-heated steam = 2.25 kJ/kg K. **(13)**	**3**	Apply
8.	Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 3 MPa and 623 K and is condensed in the condenser at a pressure of 10 kPa. Measure (i) the thermal efficiency of this power plant, (ii) the thermal efficiency if steam is superheated to 873 K instead of 623 K. **(13)**	**3**	Apply
9.	Steam at 30 bar and 350°C is expanded in a non-flow isothermal process to a pressure of 1 bar. The temperature and the pressure of the surroundings are 25°C and 100 kPa respectively. Determine the maximum work that can be obtained from this process per kg of steam. Also find the maximum useful work.	**4**	Anayze
10.	A simple Rankine Cycle works between pressure 28 bar and 0.06 bar, the initial condition of steam being dry Saturated. Calculate the Cycle Efficiency, Work Ratio and SFC. **(13)**	**3**	Apply
11.	**i)** Discuss about boiler accessories with examples. **(5)** **ii)** Explain the function of pressure gauge and fusible plug. **(8)**	**2** **2**	Understand Understand

12.	**i)** Estimate the internal energy and enthalpy of steam when the steam conditions at 10 bar are i) 0.8% dry and ii) 320°C. **(8)** **ii)** Explain the function of economizer and super heater used in boilers. **(5)**	**3** **2**	Apply Understand
13.	In a steam power plant the condition of steam at inlet to the steam turbine is 20 bar and 300˚C and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperatures. Determine (1) The quality of steam at turbine exhaust (2) Network per kg of steam (3) Cycle efficiency (4) The steam rate. Neglect pump work. **(13)**	**5**	Evaluate
14.	**i)** Calculate the efficiency of a steam power plant operating on Rankine cycle between pressure limits of 30 bar and 0.04 bar. Steam at turbine inlet is dry saturated. **(7)** **ii)** Point out the quantity of heat required to produce 1 kg of steam at a pressure of 6 bar and at a temperature of 25°C When the steam is wet having a dryness fraction of 0.9. **(6)**	**4** **4**	Analyze Analyze
15.	A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50^0C and 25^0C. The heat transfer to the engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 400 kJ. Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50^0C. **(13)**	**5**	Evaluate
16.	Steam at 50 bar and 400°C expands in a Rankine cycle to 0.34 bar. For a mass flow rate of 150 kg/s of steam, determine Power developed, Thermal efficiency and Specific steam consumption. **(13)**	**4**	Analyze
17.	Steam at 480°C, 90 bar is supplied to a Rankine cycle. It is reheated to 12 bar and 480°C. the minimum pressure is 0.07 bar. Calculate the work output and the cycle efficiency using steam	**5**	Evaluate

	tables with and without considering the pump work. **(13)**		
18.	The steam conditions at inlet to the turbine are 42 bar and 500˚C, and the condenser pressure is 0.035 bar. Assume that the steam is just dry saturated on leaving the first turbine, and is reheated to its initial temperature. Calculated the Rankine cycle efficiency and specific steam consumption with reheating by neglecting the pump work using Mollier chart. **(13)**	**5**	Evaluate
	PART C		
1.	Two boilers discharge equal amounts of steam into the same main. The steam from one is at 18 bar and 380°C and from the other at 18 bar and 95% quantity. Determine i)the equilibrium condition after mixing (4) ii) the loss of entropy by the high temperature steam (4) iii) gain of entropy of low temperature steam (4) iv) net increase or decrease of entropy (3)	**4**	Analyze
2.	Explain the working principle of steam power plant with the help of P-V and T-S diagrams. How do you design the efficiency of the steam power plant to be improved? **(15)**	**6**	Create
3.	Why boiler mountings are essential in a boiler? Design the different mountings with neat sketch. **(15)**	**6**	Create
4.	Illustrate in detail the methods of increasing the thermal efficiency of a Rankine cycle. **(15)**	**5**	Evaluate
5.	In a Rankine Cycle, the steam at inlet to the turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine i. The pump work ii. The turbine work iii. The condenser heat flow iv. The dryness at the end of expansion. Assume flow rate of 9.5kg/s. **(15)**	**4**	Analyze
6.	Consider a steam power plant that operates on a reheat Rankine cycle and has a net power output of 80MW. Steam enters the high-pressure turbine at 10 MPa and 500˚C and the low-pressure turbine at 1 MPa and 500˚C. Steam leaves the condenser as a	**4**	Anayze

	saturated liquid at a pressure of 10 kPa. The isentropic efficiency of the turbine is 80 percent, and that of the pump is 95 percent. Show the cycle on a T-s diagram with respect to saturation lines, and determine, (i) The quality (or temperature, if superheated) of the steam at the turbine exit, (ii) The thermal efficiency of the cycle, and (iii) The mass flow rate of the steam. **(15)**		