SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur– 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

ME3466 THERMAL ENGINEERING

QUESTION BANK

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UNIT I–BASIC STEAM POWER CYCLES

Carnot Cycle - Rankine Cycle- Modified Rankine Cycle- Regenerative Cycle - Reheat Cycle.

PART-A (2 Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1	Write a short note on Mollier Chart.	BT-1	Remembering
2	What are compressed solid and compressed liquid?	BT-1	Remembering
3	Discuss the critical condition of steam.	BT1	Remembering
4	Illustrate meant by dead state.	BT-1	Understanding
5	Superheated steam at 30 bar and 300°C enters a turbine and expanded to 5 bar and quality 0.974 dryness, Infer the loss in availability for the adiabatic process if the atmospheric temperature is 270°C.	BT-2	Understanding
6	Define pure substance.	BT-1	Remembering
7	Recite triple point represented in P-V diagram.	BT-1	Remembering
8	Infer the terms, Degree of super heat, degree of sub-cooling.	BT-2	Understanding
9	Discuss latent heat of vaporization.	BT-1	Remembering
10	Draw P-T (Pressure-Temperature) diagram of a pure substance.	BT-2	Understanding
11	Give the possible ways to increase thermal efficiency of Rankine cycle.	BT-1	Remembering
12	Summarize the advantages of using superheated steam in turbines.	BT-2	Understanding
13	Name the different components in steam power plant working on Rankine cycle.	BT-1	Remembering
14	Why is excessive moisture in steam undesirable in steam turbines?	BT-2	Understanding
15	Draw the standard Rankine cycle on P-V and T-S coordinates	BT-2	Understanding
16	Classify the effects of condenser pressure on the Rankine Cycle.	BT-2	Understanding
17	Show Carnot cycle cannot be realized in practice for vapour power cycles.	BT-2	Understanding
18	State the advantages of regenerative cycle.	BT-2	Understanding
19	Describe the different operations of Rankine cycle.	BT-1	Remembering
20	Outline the various operation of a Carnot cycle.	BT-2	Understanding
21	Define saturation pressure and saturation temperature.	BT-1	Remembering

22	What do you understand by triple point and critical point?		BT-1	Remembering
23	Outline the p-T diagram? What is its use?		BT-2	Understanding
24	What do you mean by the entropy of superheated steam		BT-1	Remembering
25	What do you understand by the degree of superheat and the degree of subcooling?		BT-1	Remembering
PART-B				
1	A vessel having a capacity of 0.05 m3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Examine the following : (i) The pressure, (ii) The mass, (iii) The specific volume, (iv) The specific enthalpy, (v) The specific entropy, and (vi) The specific internal energy.	16	BT-4	Analysing
2	1000 kg of steam at a pressure of 16 bar and 0.9 dry is generated by a boiler per hour. The steam passes through a superheater via boiler stop valve where its temperature is raised to 380°C. If the temperature of feed water is 30°C, determine : (i) The total heat supplied to feed water per hour to produce wet steam. (ii) The total heat absorbed per hour in the superheater. Take specific heat for superheated steam as 2.2 kJ/kg K	16	BT-5	Evaluating
3	Steam at 120 bar has a specific volume of 0.01721 m^3/kg, find the temperature, enthalpy and the internal energy.	16	BT-1	Remembering
4	Calculate the internal energy per kg of superheated steam at a pressure of 10 bar and a temperature of 300°C. Also find the change of internal energy if this steam is expanded to 1.4 bar and dryness fraction 0.8	16	BT-5	Evaluating
5	A rigid vessel of 10 m^3 volume contains steam at 4 MPa and 80% quality. Evaluate (a) the enthalpy (b) internal energy of the steam and (c) entropy of the steam.	16	BT-5	Evaluating
6	A processing plant requires wet steam at 10 bar, 0.9 dry and 3000 m^3/h. Analyse (a) The mass of steam supplied per hour (b) The quantity of fuel required Boiler efficiency = 0.35, Calorific value (C.V.) of fuel = 45000 kJ/kg	16	BT-4	Analysing

7	With a neat sketch explain the working process of Rankine cycle with its pv diagram.	16	BT-1	Remembering
8	With a neat sketch explain the efficiency improvement methods in Rankine cycle with its pv diagram.	16	BT-2	Understanding
9	With a neat sketch explain the working process of Binary combined cycle with its pv diagram.	16	BT-2	Understanding
10	In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work.	16	BT-4	Analysing
11	A Rankine cycle operates between pressures of 80 bar and 0.1 bar. The maximum cycle temperature is 600°C. If the steam turbine and condensate pump efficiencies are 0.9 and 0.8 respectively, Analyze the specific work and thermal efficiency.	16	BT-4	Analysing
12	A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagrams. Evaluate: (i) Quality of steam at turbine exhaust ; (ii) Cycle efficiency (iii) Steam rate in kg/kWh	16	BT-5	Evaluating
13	A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.	16	BT-5	Evaluating
14	A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 395°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle ?	16	BT-3	Applying
15	A binary-vapour cycle operates on mercury and steam. Saturated mercury vapour at 4.5 bar is supplied to the mercury turbine, from which it exhausts at 0.04 bar. The mercury condenser generates saturated steam at 15 bar which is expanded in a steam turbine to 0.04	16	BT-1	Remembering

	bar. (a) Find the overall efficiency of the cycle.			
16	A textile factory requires 10,000 kg/h of steam for process heating at 3 bar saturated and 1000 kW of power, for which a back pressure turbine of 70% internal efficiency is to be used. Find the steam condition required at the inlet to the turbine.	16	BT-4	Analysing
17	Steam at a pressure of 15 bar and 250°C is expanded through a turbine at first to a pressure of 4 bar. It is then reheated at constant pressure to the initial temperature of 250°C and is finally expanded to 0.1 bar. Using Mollier chart, estimate the work done per kg of steam flowing through the turbine and amount of heat supplied during the process of reheat. Compare the work output when the expansion is direct from 15 bar to 0.1 bar without any reheat. Assume all expansion processes to be isentropic.	16	BT-4	Analysing
18	A power plant generating electricity is working on a binary vapour cycle. Mercury is used in upper cycle and steam in the lower cycle. The ratio of mercury flow rate to steam flow rate is 10:1 on mass basis. At an evaporation of 106 kg/h for mercury, its specific enthalpy rises by 356 kJ/kg in passing through the boiler furnace adds 586 kJ to the steam specific enthalpy. The mercury gives up 251.2 kJ/kg during condensation, and the steam gives up 2003 kJ/kg in its condenser. The overall boiler efficiency is 85%. The combined turbine mechanical and generator efficiencies are each 95% for the mercury and steam units. The steam auxiliaries require 5% of the energy generated by the units. Estimate the overall efficiency of the plant.	16	BT-5	Evaluating

UNIT II - GAS POWER CYCLES

Air Standard Cycles - Otto, Diesel and Dual – Calculation of mean effective pressure, and air standard efficiency Comparison of cycles

PART-A (2 Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1	Define a cycle.	BT-1	Remembering
2	Define Air Standard Efficiency.	BT-1	Remembering
3	List out the assumptions to be considered for the analysis of all air standard cycles.	BT-1	Remembering
4	Plot the Otto cycle process by its p-V and T-s planes.	BT-6	Create

5	Construct the Diesel cycle on p-V and T-s planes.	BT-6	Create
6	Construct the dual cycle on the p-V plane and mention the five thermodynamic processes involved.	BT-6	Create
7	Draw the dual cycle on T-s planes and mention the five thermodynamic processes involved.	BT-3	Apply
8	Define mean effective pressure.	BT-1	Remembering
9	In an Otto cycle, the compression ratio is 8. Calculate the air standard cycle efficiency.	BT-3	Apply
10	Describe relative efficiency.	BT-2	Understanding
11.	Summarize the compression ratio.	BT-2	Understanding
12.	Define cut-off ratio.	BT-1	Remembering
13.	Define expansion ratio.	BT-1	Remembering
14.	Compare the major differences between Otto and Diesel Cycle.	BT-4	Analyse
15.	List the merits and demerits of the Otto cycle.	BT-1	Remembering
16.	Describe a thermodynamic cycle?	BT-2	Understanding
17.	Name the various gas power cycle.	BT-1	Remembering
18.	Justify the change in compression ratio to affect the air standard efficiency of an ideal Otto cycle.	BT-5	Evaluate
19.	Justify diesel efficiency changes with an increase in the cut-off ratio for the same compression ratio.	BT-5	Evaluate
20.	Label the various Gas Power Cycles.	BT-1	Remembering
21.	List the four thermodynamic processes involved in the Otto cycle	BT-1	Remembering
22.	Lable the four thermodynamic processes involved in the Diesel cycle.	BT-1	Remembering
23.	In an engine working on an Otto cycle, temperatures at the beginning at the end of compression are 27° C and 327° C respectively. Find the compression ratio and air standard efficiency of the engine.	BT-2	Understanding
24.	In an Otto cycle, the compression ratio is 11. Calculate the air standard cycle efficiency.	BT-3	Apply
25.	Illustrate the use of air standard cycle analysis.	BT-2	Understanding

PART-B (13 Marks)

1	Explain the Otto cycle with p-V and T-s diagram and derive the expression for air standard efficiency of the Otto cycle.	16	BT-2	Understanding
2.	An engine with a 250 mm bore and 375 mm stroke works on the Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. if the maximum pressure is limited to 25 bar, calculate the following: 1. The air standard efficiency of the cycle. 2. The mean effective pressure for the cycle. Assume the ideal conditions.	16	BT-3	Applying
3	The minimum pressure and temperature in an Otto cycle are 100 kPa and 27° C. the amount of heat added to the air per cycle is 1500 kJ/kg.	16	BT-3	Applying

	1. Calculate the pressure and temperatures at all points of the air standard Otto cycle. 2. Also, calculate the specific work and thermal efficiency of the cycle for a compression ratio of 8:1. Take for air: c_v = 0.72 kJ/kg K and γ = 1.4			
4	In a constant volume Otto cycle the pressure at the end of compression is 15 times that at the start, the temperature of the air at the beginning of compression is 38º C and the maximum temperature attained in the cycle is 1950º C. Solve : 1. Compression ratio. 2. Thermal efficiency of the cycle. 3. Work done. Take γ for air = 1.4.	16	BT-3	Applying
5	An engine working on the Otto cycle has a volume of 0.45 m^3, pressure 1 bar and temperature of 30º C at the beginning of the compression stroke. At the end of the compression stroke, the pressure is 11 bar. Heat added during the constant volume process is 210 kJ. Calculate : 1. Pressures, temperatures and volumes at salient points in the cycle. 2. Percentage clearance. 3. Air standard efficiency. 4. Mean effective pressure. 5. Ideal power developed by the engine, if the number of working cycles per minute is 210. Assume the cycle is reversible.	16	BT-3	Applying
6.	Compose the mean effective pressure of an Otto cycle in terms of compression ratio.	16	BT-6	Create
7.	Explain the Diesel cycle with p-V and T-s diagrams and compile the expression for air standard efficiency of the Diesel cycle.	16	BT-6	Create
8.	A diesel engine has a compression ratio of 15 and heat addition at constant pressure takes at 6 % of the stroke. Evaluate the air standard efficiency of the engine. Take γ for air as 1.4	16	BT-5	Evaluate
9.	An engine with a 200 mm cylinder diameter and 300 mm stroke works on the theoretical Diesel cycle. The initial pressure and temperature of the air used are 1 bar and 27^0C. The cut-off is 8% of the stroke. Evaluate 1. Pressure and temperatures at all salient points. 2. Theoretical air standard efficiency. 3. Mean effective pressure. 4. Power of the engine if the working cycles per minute are 380. Assume that the compression ratio is 15 and the working fluid is air. Consider all conditions to be ideal	16	BT-5	Evaluate
10.	Explain the Dual cycle with p-v and T-s diagram and develop the expression for air standard efficiency of the Dual cycle.	16	BT-6	Create
11.	The swept volume of a diesel engine working on dual is 0.0053 m^3 and clearance volume is 0.00035 m^3. The maximum pressure is 65 bars. Fuel injection ends at 5 percent of the stroke. The temperature and pressure at the compression are 80º C and 0.9 bar. Evaluate the air standard efficiency of the cycle. Take γ for air = 1.4.	16	BT-5	Evaluate
12.	An oil engine working on the dual combustion cycle has a compression ratio 14 and the explosion ratio obtained from an	16	BT-3	Applying

	indicator card is 1.4. If the cut-off occurs at 6 percent of stroke, find the ideal efficiency. Take γ for air as 1.4.			
13.	The compression ratio for a single–cylinder engine operating on dual cycle is 9. The maximum pressure in the cylinder is limited to 60 bar. The pressure and temperature of the air at the beginning of the cycle is 1 bar and 30^o C. heat is added during constant pressure process up to 4 percent of the stroke. Assuming the cylinder diameter and stroke length as 250 and 300 mm respectively, Calculate : 1. The air standard efficiency of the cycle. 2. The power developed is the number of working cycles is 3 per second. Take for air c_v = 0.71 kJ/kg K and c_p = 1.0 kJ/kg K.	16	BT-3	Applying
14	In an engine working on dual cycle, the temperature and pressure at the beginning of the cycle are 90^0 C and 1 bar respectively. The compression ratio is 9. The maximum pressure is limited to 68 bars and total heat supplied per kg of air is 1750 kJ. Solve : 1. Pressure and temperatures at all salient points 2. Air standard efficiency 3. Mean Effective Pressure.	16	BT-3	Applying
15	An air standard Otto cycle has a volumetric compression ratio of 6, the lowest cycle pressure of 0.1 MPa and operates between temperature limits of 27^{o}C and 1569^{o}C. Calculate the temperature and pressure after the isentropic expansion (ratio of specific heats = 1.4.	16	BT-3	Applying
16	The minimum pressure and temperature in an Otto cycle are 100 kPa and 30^o C. the amount of heat added to the air per cycle is 1600 kJ/kg. 1. Calculate the pressure and temperatures at all points of the air standard Otto cycle. 2. Also, calculate the specific work and thermal efficiency of the cycle for a compression ratio of 8:1. Take for air: c_v = 0.72 kJ/kg K and γ = 1.4	16	BT-3	Applying
17	An engine with a 180 mm cylinder diameter and 270 mm stroke works on the theoretical Diesel cycle. The initial pressure and temperature of the air used are 1 bar and 30^{0}C. The cut-off is 8% of the stroke. Calculate 1. Pressure and temperatures at all salient points. 2. Theoretical air standard efficiency. 3. Mean effective pressure. 4. Power of the engine if the working cycles per minute are 400. Assume that the compression ratio is 15 and the working fluid is air. Consider all conditions to be ideal.	16	BT-3	Applying
18	The compression ratio for a single–cylinder engine operating on dual cycle is 8. The maximum pressure in the cylinder is limited to 60 bar. The pressure and temperature of the air at the beginning of the cycle is 1 bar and 27^o C. heat is added during constant pressure process up to 5 percent of the stroke. Assuming the cylinder diameter and stroke length as 240 and 310 mm respectively, Calculate : 1. The air standard efficiency of the cycle. 2. The power developed is the number of working cycles is 3 per second. Take for air c_v = 0.71 kJ/kg K and c_p = 1.0 kJ/kg K.	16	BT-3	Applying

UNIT III-INTERNAL COMBUSTION ENGINES AND PERFORMANCE			
IC engine – Classification and application IC engine - Theoretical and actual Valve timing diagrams - Port time diagram - Theoretical and actual p-V diagrams of a four stroke Otto and Diesel cycle engine. Performance parameters and calculations.			
PART-A (2 Marks)			
S.No	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1.	Define heat engine.	BT-1	Remembering
2.	List the classification of heat engines.	BT-1	Remembering
3.	Label the application of I.C. engines	BT-1	Remembering
4.	List the classification of I.C. engines-based combustion.	BT-1	Remembering
5.	Summarize the eight major parts of I.C. Engines.	BT-2	Understanding
6.	Compare the flywheel and governor	BT-4	Analysing
7.	Label the types of governors.	BT-1	Remembering
8.	Construct a typical valve timing diagram and mention ideal angles.	BT-6	Create
9.	Describe swept volume.	BT-2	Understanding
10.	Describe clearance volume.	BT-2	Understanding
11.	List the functions of the push rod and rocker's arm	BT-1	Remembering
12.	Name the function of the engine flywheel.	BT-1	Remembering
13.	State the function of Connecting rod.	BT-1	Remembering
14.	Recall the function of the piston.	BT-1	Remembering
15.	Reproduce the function of the crankshaft	BT-1	Remembering
16	Define the term brake power.	BT-1	Remembering
17	Define the term Indicated power.	BT-1	Remembering
18.	Describe Air-Fuel ratio.	BT-1	Remembering
19.	List out the measurements are usually undertaken to evaluate the performance of an engine.	BT-1	Remembering
20.	List out the common form of absorption dynamometers	BT-1	Remembering
21.	List out the types of dynamometers.	BT-1	Remembering
22.	What is meant by mean effective pressure?	BT-1	Remembering
23.	Discuss Specific fuel consumption.	BT-2	Understanding
24.	Define thermal efficiency.	BT-1	Remembering
25.	What do you mean by dynamometer?	BT-1	Remembering

PART-B (16 Marks)				
1.	Categorize the Classification of IC Engines.	16	BT-4	Analyse
2.	Discuss the basic idea of the IC engine with a neat sketch and its different parts of IC engines.	16	BT-2	Understanding
3.	Explain the construction, operation of four stroke petrol engine with a neat sketch	16	BT-1	Remembering
4.	Discuss the technical terms connected with I.C. engines with a neat sketch.	16	BT-2	Understanding
5.	Construct the theoretical and actual p-V diagram of four stroke Otto cycle engine.	16	BT-6	Create
6.	Construct the theoretical and actual p-V diagram of four stroke diesel cycle engine.	16	BT-6	Create
7.	Construct the actual valve time diagram for four-stroke diesel cycle engine.	16	BT-6	Create
8.	Explain the construction, operation of two stroke petrol engine with a neat sketch and p-V diagram for the same.	16	BT-2	Understanding
9.	Summarize the comparison between four-stroke and two-stroke cycle engines.	16	BT-4	Analysing
10.	Summarize the list of engine parts, material to be used and method of manufacture and its functions	16	BT-4	Analysing
11.	Construct the typical Port timing diagram and the significance of each angle in the Port timing diagram in Two Stroke Engine	16	BT-6	Create
12.	Construct the typical theoretical and actual Valve timing diagram for four stroke Otto cycle engine and the significance of each angle in the valve timing diagram.	16	BT-6	Create
13.	What do you mean by the performance of the IC engine? Discuss briefly the basic performance parameters. And also discuss with a suitable sketch the brake rope dynamometer.	16	BT-2	Understanding
14.	Discuss the various basic performance parameters used to evaluate the performance of the IC engine.	16	BT-2	Understanding
15.	Describe the methods to determine the frictional power in detail.	16	BT-2	Understanding
16.	A 4-cylinder petrol engine has a bore of 60 mm and a stroke of 90 mm. Its rated speed is 2800 rpm and it is tested at this speed against brake which has a torque arm of 0.37 m. The net brake load is 160 N and the fuel consumption is 8.986 lit/hr. The specific gravity of petrol used is 0.74 and it has a lower calorific value of 44100 kJ/kg. A Morse test is carried out and the cylinders are cut out in the order 1,2,3,4 with corresponding brake loads of 110,107,104 and 110 N respectively. Evaluate for this speed:1. The engine torque, 2. B.M.E.P, 3. The brake thermal efficiency, 4. The specific	16	BT-5	Evaluating

	fuel consumption, 5. Mechanical efficiency, 6. I.M.E.P			
17.	A four cylinder four stroke S.I. engine has a compression ratio of 8 and bore of 100 mm, with stroke equal to the bore. The volumetric efficiency of each cylinder is equal to 75%. The engine operates at a speed of 4800 rpm with an air-fuel ratio 15. Given that the calorific value of fuel = 42 MJ/kg, atmospheric density = 1.12 kg/m^3, mean effective pressure in the cylinder = 10 bar and mechanical efficiency of the engine =80%, determine the indicated thermal efficiency and the brake power.	16	BT-4	Analysing
18.	Following data relate to 4-cylinder four stroke petrol engine. Air fuel ratio by weight = 16:1, calorific value of the fuel = 45200 kJ/kg, mechanical efficiency = 82%, air-standard efficiency = 52%, relative efficiency = 70%, volumetric efficiency = 78 %, stroke/bore ratio = 1.25, suction conditions = 1 bar & 25°C, r.p.m. = 2400 and power at brakes =72 kW. Evaluating: (1) Compression ratio, (2) Indicated thermal efficiency, (3) Brake specific fuel consumption, (4) Bore and Stroke.	16	BT-5	Evaluating

UNIT IV STEAM NOZZLES AND STEAM TURBINES			
PART-A (2 Marks)			
Introduction – Steam flow through nozzles – Nozzle efficiency – Classification of the steam turbine – Advantages of the steam turbine over steam engines – Methods of reducing wheel – Impulse turbine – Turbine Efficiency.			
S.NO	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1.	Define critical pressure ratio in steam flow through nozzles.	BT-1	Remembering
2.	If the enthalpy drops in a steam nozzle of efficiency 92% is 100 kJ/kg determine the exit velocity of steam.	BT-5	Evaluating
3.	What is the effect of super saturation in the nozzles?	BT - 2	Understanding
4.	Draw the Shape of Supersonic Nozzle.	BT - 3	Applying
5.	Express the effects of friction on the flow through a steam nozzle.	BT - 3	Applying
6.	Name the various types of nozzles and their function.	BT - 2	Understanding
7.	Analyze the effects of super saturation in a nozzle.	BT-4	Analysing
8.	Define nozzle efficiency.	BT-1	Remembering
9.	Where is nozzle control governing is used?	BT - 1	Remembering
10.	If the enthalpy drops in a steam nozzle of efficiency 88% is 95 kJ/kg determine the exit velocity of steam.	BT - 5	Evaluating
11	Distinguish between impulse and reaction principle.	BT - 2	Understanding
12	Discuss the importance of compounding of steam turbine.	BT - 2	Understanding
13	Define stage efficiency.	BT - 1	Remembering
14	Discuss the importance of compounding of steam turbine.	BT - 2	Understanding
15	What is meant by Pressure Compounding?	BT - 1	Remembering
16	Summarize the different losses involved in steam turbines.	BT - 5	Evaluating
17	Define Diagram efficiency.	BT - 1	Remembering
18	Explain 'Degree of Reaction' in a steam turbine.	BT - 3	Applying
19	Define a steam turbine and state its fields of application.	BT - 1	Remembering

20	How are the steam turbines classified?	BT - 4	Analysing
21	Discuss the advantages of a steam turbine over the steam engines.	BT - 2	Understanding
22	What you mean by compounding of steam turbines?	BT - 2	Understanding
23	What methods are used in reducing the speed of the turbine rotor?	BT - 2	Understanding
24	Define the term degree of reaction used in reaction turbines.	BT - 1	Remembering
25	Write a short note on bleeding of steam turbines.	BT - 1	Remembering

PART-B (13 Marks)

S.NO	QUESTIONS		LEVEL	COMPETENCE
1	Steam having pressure of 10.5 bar and 0.95 dryness is expanded through a convergent-divergent nozzle and the pressure of steam leaving the nozzle is 0.85 bar. Find the velocity at the throat for maximum discharge conditions. Index of expansion may be assumed as 1.135. Calculate mass rate of flow of steam through the nozzle.	16	BT-5	Evaluating
2	Dry saturated steam enters a frictionless adiabatic nozzle with negligible velocity at a temperature of 300°C. It is expanded to pressure of 5000 KPa. The mass flow rate is 1 kg/s. Calculate the exit velocity of the steam.	16	BT-5	Evaluating
3	Steam is expanded in a set of nozzles from 10 bar and 200°C to 5 bar. What type of Nozzle is it? Neglecting the initial velocity find minimum area of the nozzle required to allow a flow of 3 kg/s under the given conditions. Assume that expansion of steam to be isentropic.	16	BT-5	Evaluating
4	In a steam nozzle, the steam expands from 4 bar to 1 bar. The initial velocity is 60 m/s and the initial temperature is 200°C. Determine the exit velocity if the nozzle efficiency is 92%.	16	BT-5	Evaluating
5	Derive the expression for critical pressure ratio in terms of index of expansion.	16	BT-5	Evaluating
6	Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2 bar. If the dryness fraction of discharge steam is 0.96, what will be the final velocity of steam? Neglect initial velocity of steam. If 10% of heat drop is lost in friction, Examine (find) the percentage reduction in the final velocity.	16	BT - 5	Evaluating

7	Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine: (i) The exit velocity of steam. (ii) Ratio of cross section at exit and that at throat. Assume the index of adiabatic expansion to be 1.135.	16	BT - 6	Creating
8	Explain with a neat sketch of velocity compounding, pressure compounding, pressure-velocity compounding.	16	BT-3	Applying
9	In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical in shape. The outlet angle of the moving blades in 19° and the absolute discharge velocity of steam is 100 m/s in the direction 70° to the motion of the blades. If the rate of flow through the turbine is 15000 kg/hr., calculate the power developed by the turbine.	16	BT - 4	Analysing
10	A stage of a steam turbine is supplied with steam at a pressure of 50 bar and 350oC, and exhausts at a pressure of 5 bar. The isentropic efficiency of the stage is 0.82 and the steam consumption is 2270 kg/min. Determine the power of the stage.	16	BT - 3	Applying
11	The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/s. The blades operate close to maximum blading efficiency. The nozzle angle is 20°. Considering equiangular blades and neglecting blade friction, calculate for a steam flow of 0.6 kg/s, the diagram power and the diagram efficiency.	16	BT - 3	Applying
12	Steam enters the blade row of an impulse turbine with a velocity of 600m/s at an angle of 25°C to the plane of rotation of blades. The mean blade speed is 200m/s. the blade angle at the exit is 30°. The blade friction loss is 10%. Determine (i) The blade angle at inlet (ii) The work done per kg of steam (iii)The diagram efficiency (iv)The axial thrust per kg of steam per second.	16	BT - 3	Applying
13	In a stage of impulse reaction turbine, steam enters with a speed of 250 m/sec, at an angle of 30° in the direction of blade motion. The mean speed of the blade is 150 m/sec. when the rotor is running at 3000 r.p.m. The blade height is 10 cm. The specific volume of steam at nozzle outlet and blade outlet are 3.5 m^3/kg and 4 m^3/kg respectively. The turbine	16	BT - 3	Applying

	develops 250 kW. Assuming the Efficiency of nozzle and blades combinedly considered is 90% and carryover coefficient is 0.8 ; find (i) The enthalpy drop in each stage (ii) Degree of reaction (iii) Stage efficiency.			
14	The blade speed of a single ring of an impulse turbine is 300 m/s and the nozzle angle is 20°. The isentropic heat drop is 473 kJ/kg and the nozzle efficiency is 0.85. Given that the blade velocity coefficient is 0.7 and the blades are symmetrical, draw the velocity diagrams and calculate for a mass flow of 1 kg/s: (i) Axial thrust on the blading. (ii) Steam consumption per B.P. hour if the mechanical efficiency is 90 per cent. (iii) Blade efficiency and stage efficiency	16	BT - 3	Applying
15	In a 50 percent reaction turbine stage running at 50 revolutions per second, the exit angles are 30° and the inlet angles are 50°. The mean diameter is 1m. The steam flow rate is 10000 kg/mm and the stage efficiency is 85%. Determine (i) The power output of the stage (ii) The specific enthalpy drop in the stage and (iii) The percentage increase in the relative velocity of steam when it flows over the moving blades.	16	BT - 3	Applying
16	300 kg/min of steam (2 bar, 0.98 dry) flows through a given stage of a reaction turbine. The exit angle of fixed blades as well as moving blades is 20° and 3.68 kW of power developed. If the rotor speed is 360 rpm. and tip leakage is 5 percent, calculate the mean drum diameter and the blade height. The axial flow velocity is 0.8 times the blade velocity.	16	BT - 6	Creating
17	In a stage of impulsive reaction turbine, steam enters with a speed of 250 m/s at an angle of 30° in the direction of blade motion. The mean speed of the blade is 150 m/s when the rotor is running at 3000 r.p.m. The blade height is 10 cm. The specific volume of steam at nozzle outlet and blade outlet are 3.5 m^3/kg and 4 m^3/kg respectively. The turbine develops 250 kW. Assuming the efficiency of nozzle and blades combined considered is 90% and carryover coefficient is 0.8, find (i) The enthalpy drop in each stage, (b) Degree of reaction and (iii) Stage efficiency.	16	BT - 5	Evaluating
18	A simple impulse turbine has one ring of moving blades running at 150 m/s. the absolute velocity of steam at exit from the stage is 85 m/s at an angle of 80° from the tangential direction. Blade velocity co-			

	efficient is 0.82 and the rate of steam flowing through the stage is 2.5 kg/s. if the blades are equiangular, determine: (i) Blade angles (ii)Nozzle angle (iii)Absolute velocity of the steam issuing from the nozzle (iv)Axial thrust.	16	BT - 5	Evaluating

UNIT V - PSYCHROMETRICS AND REFRIGERATION

Concept of Psychrometry and Psychrometrics - Definitions - Psychrometric Charts- Psychrometric Processes - Fundamentals of refrigeration – Air refrigeration system – Simple vapour compression system – Vapour absorption system

PART-A (2 Marks)

S.NO	QUESTIONS	LEVEL	COMPETENCE
1	Define Psychometric.	BT-1	Remembering
2	What is moist air?	BT-1	Remembering
3	Summarize various psychometric processes.	BT-2	Understanding
4	Give the application where heating and humidification of air used.	BT-2	Understanding
5	List various types of air conditioning.	BT-1	Remembering
6	Compare evaporative cooling and adiabatic mixing.	BT-4	Analyze
7	Define adiabatic saturation temperature.	BT-1	Remembering
8	Summarize why humidification of air is necessary.	BT-2	Understanding
9	How the wet bulb temperature does differ from the dry bulb temperature.	BT-2	Understanding
10	Express the term bypass factor.	BT-2	Understanding
11	Define dew point temperature.	BT-1	Remembering
12	What is chemical dehumidification?	BT-1	Remembering
13	Summarize why wet clothes dry in sun faster.	BT-2	Understanding
14	Define refrigeration effect.	BT-1	Remembering
15	Draw the Electrolux refrigeration system.	BT-2	Understanding
16	Discuss the working principle of air cycle.	BT-2	Understanding
17	What is the function of the throttling valve in vapour compression	BT-1	Remembering

	refrigeration system?		
18	Write down four important properties of a good refrigerant.	BT-2	Understanding
19	Define super heating.	BT-1	Remembering
20	Illustrate the necessity of refrigeration.	BT-3	Applying
21	Estimate the effect of super heat and sub cooling on the vapour compression cycle.	BT-5	Evaluating
22	Compare vapor compression and vapor absorption system	BT-5	Evaluating
23	Point out the unit of refrigeration, with an example.	BT-3	Applying
24	Evaluate the functions of Cooling load calculations.	BT-5	Evaluating
25	Define thermoelectric refrigeration. .	BT-1	Remembering

PART-B (16 Marks)

1	Define psychrometric process. Explain various psychrometric process in detail with neat sketch.	16	BT-4	Analysing
2.	Explain the following Air Conditioning Process. a) Sensible cooling and Sensible heating process. b) Cooling and dehumidification process. c) Evaporative cooling.	16	BT-4	Analysing
3.	Atmospheric air at 1.0132 bar has a DBT of 30˚C and WBT of 25˚C. Calculate (i) the partial pressure of water vapour (ii) specific humidity (iii) the dew point temperature (iv) the relative humidity (v) the degree of saturation (vi) the density of air in the mixture (vii) the density of vapour in the mixture and (viii) the enthalpy of the mixture. Use the thermodynamic tables only.	16	BT-3	Applying
4.	Atmospheric air at 38˚C and 25% relative humidity passes through an evaporator cooler. If the final temperature of air is 18˚C, how much water is added per kg of dry air and what is the	16	BT-3	Applying

	final relative humidity?			
5.	0.004 kg of water vapor per kg of atmospheric air is removed and temperature of air after removing the water vapor becomes 20°C. Determine: (i) Relative humidity (ii) Dew point temperature. Assume that condition of atmospheric air is 30°C and 55% R.H. and pressure is 1.0132 bar.	16	BT-5	Evaluating
6.	A sling psychometric reads 40ºC DBT and 36ºC WBT. Find the humidity ratio, relative humidity, DPT, specific volume of air, density of air, density of water vapor and enthalpy.	16	BT-5	Evaluating
7.	Saturated air at 21ºC is passed through a drier so that the final relative humidity is 20%. The air is then passed through a cooler until its final temperature is 21ºC without a change in specific humidity. Find (i) The temperature of air after drying process, (ii) the heat rejected in cooling process, (iii) the dew point temperature at the end of drying process.	16	BT-5	Evaluating
8.	40 m^3 of air per minute at 31ºC DBT and 18.5ºC WBT is passed over the cooling coil whose surface temperature is 4.4ºC. The coil cooling capacity is 3.56 tons of refrigeration under the given condition of air. Determine DBT and WBT of the air leaving the cooling coil.	16	BT-5	Evaluating
9.	A sling psychometric in a laboratory test recorded the following readings. Dry bulb temperature = 35°C, Wet bulb temperature = 25°C Calculate the following (i) specific humidity (ii) relative humidity (iii) vapor density in air (iv) dew point temperature and (v) enthalpy of mixture per kg of dry air Take atmospheric pressure = 1.0132 bar.	16	BT-5	Evaluating
10.	Consider the room contains air at 1 atm, 35°C and 40% RH. Using the Psychometric chart determine, specific humidity, enthalpy, WBT, DPT, specific volume of the air.	16	BT-5	Evaluating
11.	The capacity of a refrigerator is 200 TR when working between –6°C and 25°C. Determine the mass of ice produced per day from water at 25°C.Also find the power required to drive the unit. Assume that the cycle operates on reversed Carnot cycle and latent heat of ice is 335kJ/kg.	16	BT-4	Analyzing
12.	Five hundred kg of fruits are supplied to a cold storage at 20ºC. The	16	BT-4	Analyzing

	cold storage is maintained at 5°C and the fruits get cooled to the storage temperature in10 hours. The latent heat of freezing is 105 kJ/kg and specific heat of fruit is1.256 kJ/kg K. Find the refrigeration capacity of the plant.			
13.	Explain the working of a simple vapor absorption refrigeration system with neat diagram.	16	BT-4	Analyzing
14.	A Refrigerating machine working between the temperature limits of 13 ºC and 37ºC and has 90% relative COP. It consumes 4.8 kW power. Determine TR capacity. For same TR capacity, how much power will be consumed by Carnot refrigerator? Also for the same power consumption, determine TR capacity of Carnot refrigerator operating between same temperature limits.	16	BT-4	Analyzing
15.	Explain the working of a simple vapor compression refrigeration system with neat diagram	16	BT-4	Analyzing
16.	Explain the concept of RSHF, GSHF and ESHF, with suitable examples.	16	BT-4	Analyzing
17.	Explain unitary and central air conditioning systems and their application in contemporary industries.	16	BT-3	Applying
18.	Exp1ain summer Air Conditioning with a neat layout.	16	BT-4	Analyzing