SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur– 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

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QUESTION BANK

SUBJECT / SUBJECT CODE : THERMAL ENGINEERING / 1909501

SEM/YEAR : V / III

UNIT I–BOILERS

Types and comparison. Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance calculations, Boiler trial.

PART-A (2 Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	What is water level indicator?	BT-1	Remembering
2.	Define boiler efficiency.	BT-1	Remembering
3.	Define equivalent evaporation from and at 100^0C.	BT-1	Remembering
4.	Define boiler thermal efficiency.	BT-1	Remembering
5.	Discuss chemical fuel.	BT-3	Applying
6.	Types of Boiler Fuel.	BT-2	Understanding
7.	What are primary fuels? List some important fuels.	BT-2	Understanding
8.	Define heating value of fuel.	BT-2	Understanding
9.	Explain the function of the boiler chimney.	BT-1	Remembering
10.	Why is there no chimney in the case of a locomotive boiler?	BT-1	Remembering
11.	What is safety valve? And define safety valve.	BT-4	Analysing
12.	Explain various types of draughts used in usual practice.	BT-1	Remembering
13.	Merits and demerits of the dead weight safety valve.	BT-3	Applying
14.	Define fusible plug.	BT-6	Creating
15.	How to working boiler injector?	BT-6	Creating
16.	Write the draught losses.	BT-2	Understanding
17.	Discuss steam jet draught.	BT-2	Understanding
18.	Write the power of F.D & I.D fan equations.	BT-1	Remembering
19.	Write short notes on bomb calorimeter.	BT-5	Evaluating
20.	What is Junkers gas calorimeter?	BT-4	Analysing

21.	What happen if the boiler injector pressure increases during the operation?		BT-6	Creating
22.	Compare the types of draught.		BT-5	Evaluating
23.	Define steam boiler and list its function.		BT-6	Creating
24.	List the types of boilers according to various factors		BT-1	Remembering
25.	List the advantages of Cochran boilers		BT-1	Remembering
	PART-B			
1.	Explain the function of boiler mountings. Can a boiler work without mountings.	13	BT-3	Applying
2.	Explain in detail about how accessories differ from mountings.	13	BT-3	Applying
3.	Enumerate the various accessories normally used in a steam generating plant.	13	BT-1	Remembering
4.	Discuss the function of a safety value. State the minimum number of safety value to be used in boiler.	13	BT-2	Understanding
5.	Explain fusible plug and state where it is located in a boiler	13	BT-3	Applying
6.	Explain with neat sketch any three of the following mounting: (i) Water level indicator (ii) Pressure gauge (iii) Feed check value (iv) Blow of cock (v) High steam and low water safety value (vi) Junction or stop value	13	BT-3	Applying
7.	Give a schematic sketch of a boiler plant. What are the observations to be recorded during a boiler trial?	13	BT-1	Remembering
8.	Explain what the sources of heat losses in boiler plants are. What are the methods used to reduce these losses?	13	BT-3	Applying
9.	With the help of neat sketch, explain and injector for feeding water to the boiler drum. Why it is not used for large capacity boilers? Explain its location in boiler installation.	13	BT-4	Analysing
10.	Explain with neat sketches any two of the following boiler accessories: (i) Injector (ii) super heater (iii) Air preheated (iv) Economizer.	13	BT-3	Applying

11.	Explain with neat sketch expansion type of steam trap.	13	BT-3	Applying
12.	Explain the function of steam separator. Discuss with a neat sketch anyone types of steam separators.	13	BT-4	Analysing
13.	A boiler generates 13000kg of steam at 7 bars during a period of 24 hrs and consume 1250 kg of coal whose CV. = 30000 kJ/kg. Taking the enthalpy of steam coming out of boiler = 2507.7 kJ/kg and water is supplied to the boiler at 40°C. Find: (a) efficiency of the boiler (b) Equivalent evaporation per kg of coal.	13	BT-6	Creating
14.	Calculate the quantity of air supplied per kg of fuel burnt in the combustion chamber of the boiler when the required draught of 1.85 cm of water is produced by a chimney of 32 m height. The temperature of the flue gases and ambient air recorded are 370°C and 30°C respectively.	13	BT-6	Creating
15.	Explain the working principle of the steam jet draught.	13	BT-3	Applying
16.	Explain with neat sketch and function of the safety valve .	13	BT-3	Applying
17.	Outline the neat sketch of the Babcock and Wilcox water tube boiler.	13	BT-3	Applying
18.	Compare the advantages of high pressure boiler over low pressure boiler.	13	BT-1	Remembering
	PART-C (15 Marks)			
1.	(a)Describe with a neat diagram, the construction and working of a Babcock and Wilcox water tube boiler.	15	BT-2	Understanding
	(b) Describe with a neat line sketch of a Benson boiler mentioning its distinguishing features. State the advantages for this type of boilers.	15	BT-2	Understanding
2.	Discuss, briefly, the working of an economizer in a boiler plant giving a neat sketch.	15	BT-2	Understanding
3.	(a)A coal fired boiler plant consumes 400 kg of coal per hour. The boiler evaporates 3200 kg of water at 44.5°Cinto superheated steam at a pressure of 12 bar and 274.5°C. If the calorific value of fuel is 32760 kJ/kg of coal, determine: 1. Equivalent evaporation "from and at 100°C,'' and 2. Thermal efficiency of the boiler. Assume specific heat of superheated steam as 2.1 kJ/kg K.	10	BT-6	Creating
	(b) Discuss briefly the term boiler efficiency.	5	BT-2	Understanding
4.	In a boiler, the following observations were made:			

	Pressure of steam = 10 bar Steam condensed = 540 kg/h Fuel used = 65 kg/h Moisture in fuel = 2% by mass Mass of dry flue gases = 9 kg/kg of fuel Lower calorific value of fuel = 32000 kJ/kg Temperature of the flue gases = 325°C Temperature of boiler house = 28°C Feed water temperature = 50°C Mean specific heat of flue gases = 1 kJ/kg K Dryness fraction of steam=0.95 Draw up a heat balance sheet for the boiler.	15	BT-5	Evaluating
5.	Construct neat sketch and explain the Lancashire boiler.	15	BT-2	Understanding

UNIT II - STEAM NOZZLE

Types and Shapes of nozzles- Flow of steam through nozzles, Critical pressure Ratio-Variation of mass flow rate with pressure Ratio-Effect of friction- Metastable flow.

PART-A (2 Marks)

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.	Explain various types of nozzles.	BT - 3	Applying
12.	Define the term stream nozzle.	BT-1	Remembering
13.	What is the effect of friction on the flow through a stream nozzle?	BT-3	Applying
14.	What you mean by a supersaturated flow?	BT-1	Remembering
15.	Explain what is meant by critical pressure ratio of a nozzle.	BT - 3	Applying
16.	The dry and saturated steam at a pressure of 5 bar is expanded isentropically in a nozzle to a pressure of 0.2 bar. Find the velocity of steam leaving the nozzle.	BT-5	Evaluating
17.	What are the effects of super saturation on discharge and heat drop?	BT-2	Understanding
18.	What is meant by overexpansion and under expansion?	BT-2	Understanding
19.	State the relation between the velocity of steam and heat during any part of a steam nozzle.	BT - 3	Applying
20.	Give the five applications of steam nozzles.	BT-2	Understanding
21.	Write down the expression for velocity at exit from steam nozzle.	BT-2	Understanding
22.	Derive the expression for critical pressure ratio in a steam nozzle.	BT-5	Evaluating
23.	Write the general energy equation for a steady flow system and from this obtain the energy equation for nozzle.	BT-2	Understanding
24.	Draw the T-S and H-S plot of super saturated expansion of steam in a nozzle.	BT - 3	Applying
25.	Differentiate supersaturated flow and isentropic flow.	BT - 3	Applying

PART-B (13 Marks)

1.	(a) Mention the types of nozzles you know, Where are these used?	3	BT - 1	Remembering
	(b) 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.	10	BT-5	Evaluating
2.	(a) Dry saturated steam enters a frictionless adiabatic nozzle with negligible velocity at a temperature of 300^{o}C. It is expanded to pressure of 5000 KPa. The mass flow rate is 1 kg/s. Calculate the exit velocity of the steam.	6	BT-5	Evaluating

	(b) Steam is expanded in a set of nozzles from 10 bar and 200^{o}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.	7	BT-5	Evaluating
3.	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^{o}C. Determine the exit velocity if the nozzle efficiency is 92%.	13	BT-5	Evaluating
4.	Derive the expression for critical pressure ratio in terms of index of expansion.	13	BT-5	Evaluating
5.	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.	13	BT - 5	Evaluating
6.	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.	13	BT - 6	Creating
7.	The nozzles of De-Laval stream turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at the outlet is 1 bar. The turbine has two nozzles with a throat diameter of 2.5 mm. Assuming nozzle efficiency as 90% and that of turbine rotor 35%, find the quality of steam used per hour and the power developed.	13	BT - 5	Evaluating
8.	Dry saturated steam at a pressure of 8 bar enters a convergent divergent nozzle and leaves it at a pressure of 1.5 bar. If the flow is isentropic and if the corresponding expansion index is 1.33, find the ratio of cross-sectional area at exit and throat for maximum discharge.	13	BT - 5	Evaluating
9.	Air at a pressure of 20 bar and at a temperature of 18°C is supplied to a convergent divergent nozzle having a throat diameter of 1.25 cm and discharging to atmosphere. The adiabatic index for air is 1.4 and the characteristic constant is 287. Find the weight of air discharged per minute.	13	BT - 5	Evaluating
10.	Derive an expression for maximum discharge through convergent	13	BT-5	Evaluating

	divergent nozzle for steam.			
11.	Steam enters a group of CD nozzles at 21 bars and 270°C. The discharge pressure of the nozzle is 0.07 bars. The expansion is equilibrium throughout and the loss of friction in convergent portion of the nozzle is negligible, but the loss by friction in the divergent section of the nozzle is equivalent to 10% of the enthalpy drop available in that section. Calculate the throat and exit area to discharge 14 kg/sec of steam.	13	BT-5	Evaluating
12.	Steam initially dry and saturated is expanded in a nozzle from 15 bar 300°C at 1 bar. if the friction loss in the nozzle is 12% of the total head drop calculate the mass of steam discharged when exit diameter of the nozzle is 15 mm.	13	BT-4	Analyzing
13.	(a)Define critical pressure ratio of a nozzle and discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle.	6	BT-3	Applying
	(b)Air enters a frictionless adiabatic converging nozzle at 10 bar500 K with negligible velocity. The nozzle discharges to a region at 2 bar. If the exit area of the nozzle is 2.5 cm^2, find the flow rate of air through the nozzle.	7	BT-4	Analysing
14	Steam enters a group of convergent-divergent nozzles at a pressure of 22 bar and with a temperature of 240°C. The exit pressure is 4 bar and 9% of the total heat drop is lost in friction. The mass flow rate is 10kg/s and the flow up to throat may be assumed friction less. Calculate 1. The throat and exit velocities, and 2. The throat and exit areas.	13	BT-5	Evaluating
15.	Steam at a pressure of 15 bar with 50° C of superheat is allowed to expand through a convergent-divergent nozzle. The exit pressure is 1 bar. If the nozzle is required to supply 2 kg/sec. of steam to the turbine, then calculate (i) The velocities at throat and exit. (ii) Areas at throat and exit Assume 10% frictional loss in divergent part only and percentage taken as % of, total heat drop.	13	BT-5	Evaluating
16.	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)	13	BT - 5	Evaluating

	The work done per kg of steam (iii)The diagram efficiency (iv)The axial thrust per kg of steam per second.			
17.	(a) Steam at a pressure of 15 bar saturated is discharged through a convergent divergent nozzle to a back pressure of 0.2 bar. The mass flow rate is 9 kg/kW-hr, if the power developed is 220 kW, determine number nozzles required if each nozzle has a throat of rectangular cross section of 4mm x 8mm. If 12% of overall isentropic enthalpy drop occurs in the divergent portion due to friction, find the cross section of the exit rectangle? (9)	9	BT - 5	Evaluating
	(b) Explain the supersaturated expansion of steam in a nozzle.	4	BT - 3	Applying
18.	(a) Derive the expression for critical pressure ratio in terms of index of expansion.	6	BT-5	Evaluating
	(b) A convergent divergent adiabatic steam nozzle is supplied with steam at 10bar and 2500C. The discharge pressure is 1.2bar. Assuming the nozzle efficiency as 100% and initial velocity of steam is 50m/s, find the discharge velocity.	7	BT - 5	Evaluating

PART-C (15 Marks)				
1.	A Convergent-Divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 6.9 bar and180^{o}C and discharge takes place against a back pressure of 0.98 bar. Expansion up to throat is isentropic and the frictional resistance between the throat and exit is equivalent to 62.76 kJ/kg of steam. Taking approach velocity of 75 m/s and throat pressure 3.9 bar, Estimate: (i) Suitable areas for the throat and Exit (ii) Overall efficiency of the nozzle based on the enthalpy drop between the actual inlet pressure, and temperature and the exit pressure.	15	BT - 6	Creating
2.	(a) Define Critical pressure ratio of nozzle and discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle.	8	BT - 3	Applying
	(b) Explain the metastable expansion of steam in a nozzle with help of h-s diagram.	7	BT - 4	Analysing
3.	In an installation 5 kg/s of steam at 30 bar and 300^{o}C is supplied to group of six nozzles in a wheel chamber maintained at 7.5 bar. (a) Determine the dimensions of the nozzles of rectangular cross-sectional flow area with aspect ratio 3: 1. The expansion may be considered meta-stable and friction is neglected. (b) Also calculate: (i) degree of under-cooling and super-saturation; (ii) loss in available drop due to irreversibility; (iii) increases in entropy (iv) Ratio of mass flow rate with meta-stable	15	BT-5	Evaluating

	expansion to that if expansion is in thermal equilibrium.			
4.	A gas expands in a convergent-divergent nozzle from 5 bar to 1.5 bar, the initial temperature being 700°C and the nozzle efficiency is 90%. All the losses take place after the throat. For 1 kg/s mass flow rate of the gas, find throat and exit areas. Take n = 1.4 and R = 287 J/kg K.	15	BT-5	Evaluating
5.	Steam at a pressure of 10.5 bar and 0.95 dry is expanded through a convergent divergent nozzle. The pressure of steam leaving the nozzle is 0.85 bar. (i) Find the velocity of steam at throat for maximum discharge take n=1.135. (ii) Also find the area at the exit and the steam discharge if the throat area is 1.2 cm^2. Assume flow is isentropic and there are no friction losses.	15	BT-5	Evaluating

UNIT III-STEAM TURBINES			
Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.			
PART-A (2 Marks)			
S.No	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1.	Distinguish between impulse and reaction principle.	BT - 2	Understanding
2.	Discuss the importance of compounding of steam turbine.	BT - 2	Understanding
3.	Define stage efficiency.	BT - 1	Remembering
4.	Discuss the importance of compounding of steam turbine.	BT - 2	Understanding
5.	What is meant by Pressure Compounding?	BT - 1	Remembering
6.	Summarize the different losses involved in steam turbines.	BT - 5	Evaluating
7.	Define Diagram efficiency.	BT - 1	Remembering
8.	Explain 'Degree of Reaction' in a steam turbine.	BT - 3	Applying
9.	Define a steam turbine and state its fields of application.	BT - 1	Remembering
10.	How are the steam turbines classified?	BT - 4	Analysing
11.	Discuss the advantages of a steam turbine over the steam engines.	BT - 2	Understanding
12.	What you mean by compounding of steam turbines?	BT - 2	Understanding
13.	What methods are used in reducing the speed of the turbine rotor?	BT - 2	Understanding
14.	Define the term degree of reaction used in reaction turbines.	BT - 1	Remembering
15.	Write a short note on bleeding of steam turbines.	BT - 1	Remembering
16.	Explain reheat factor. Why is its magnitude always greater than unity?	BT - 1	Remembering
17.	Give the classification of steam turbines.	BT - 2	Understanding
18.	Explain the principle of impulse turbines.	BT - 3	Applying
19.	What are the different losses that occur in a steam turbine?	BT - 1	Remembering
20.	State the advantages and disadvantages of reheating steam.	BT - 2	Understanding
21.	What is Curtis turbine?	BT - 1	Remembering
22.	What is blading efficiency?	BT - 1	Remembering
23.	State the functions of fixed and moving blades.	BT - 3	Applying
24.	Explain the need of compounding in steam turbines.	BT - 3	Applying
25.	What is the function of governors in steam turbines?	BT - 1	Remembering

PART-B (13 Marks)				
1.	In a certain stage of an impulse turbine, the nozzle angle is 20° with the plane of the wheel. The mean diameter of the ring is 2.8 meters. It develops 55 kW at 2400 rpm. Four nozzles, each of 10 mm diameters expand steam isentropically from 15 bar and 250°C to 0.5 bar. The axial thrust is 3.5 Calculate: 1. Blade angles at entrance and exit, and 2.power lost in blade friction.	13	BT - 4	Analysing
2.	The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/s. The blades operate close to the 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.	13	BT - 5	Evaluating
3.	The blade speed of a single ring impulse blading is 250 m/s and nozzle angle is 20°. The heat drop is 550 kJ/kg and nozzle efficiency is 0.85. The blade discharge angle is 30° and the machine develops 30 kW, when consuming 360 kg of steam per hour. Draw the velocity diagram and calculate: 1. Axial thrust on the blading and 2.the heat equivalent per kg of steam friction of the blading.	13	BT-3	Applying
4.	At a stage of reaction turbine, the mean diameter of the rotor is 1.4 m. The speed ratio is 0.7. Determine the blade inlet angle if the blade outlet angle is 20°. The rotor speed is 3000 rpm. Also find the diagram efficiency. Find the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at the best theoretical speed, the exit angle being 20°.	13	BT - 5	Evaluating
5.	In a single stage impulse turbine, the blade angles are equal and the nozzle angle is 20°. The velocity coefficient for the blade is 0.83. Find the maximum blade efficiency possible. If the actual blade efficiency is 90% of maximum blade efficiency, find the possible ratio of blade speed to steam speed.	13	BT - 4	Analysing

6.	A single stage impulse turbine rotor has a diameter of 1.2m running at 3000 rpm. The nozzle angle is 18°. Blade speed ratio is 0.42. The ratio of the relative velocity at outlet to relative velocity at inlet in 0.9. The outlet angle of the blade is 3° smaller than the inlet angle. The steam flow rate is 5 kg/s. Draw the velocity diagram and find the following: (i) Velocity of whirl (ii) Axial thrust on the bearing (iii)Blade angles (iv) Power developed	13	BT - 6	Creating
7.	A de-Level turbine it supplied with dry steam and works on a pressure range from 10.5 bar to 0.3 bar. The nozzle angle is 20° and the blade exit angle is 30°.The mean blade speed is 270 m/s. If there is a 10% loss due to friction in the nozzle and blade velocity coefficient 0.82, find the thrust on the shaft per kW power developed.	13	BT - 3	Applying
8.	Explain with a neat sketch of velocity compounding, pressure compounding, pressure-velocity compounding.	13	BT-3	Applying
9.	A 50 % reaction turbine (with symmetrical velocity triangles) running at 400 rpm has the exit angle of the blades as 20° C and the velocity of steam relative to the blades at the exit is 1.35 times the mean speed of the blade. The steam flow rate is 8.33 Kg/s and at a particular stage the specific volume is 1.381 m^3/Kg. Evaluate for this stage. (i) A suitable blade height, assuming the rotor mean diameter 12 times the blade height, and (ii) The diagram work	13	BT - 5	Evaluating
10.	A single row impulse turbine develops 132.4 kW at a blade speed of 175 m/s, using 2 kg of steam per sec. Steam leaves the nozzle at 400 m/s. Velocity coefficient of the blades is 0.9. Steam leaves the turbine blades axially. Calculate nozzle angle, blade angles at entry and exit, assuming no shock.	13	BT - 5	Evaluating

11.	A single-stage impulse turbine is supplied steam at 5 bar and 200°C at the rate of 50 kg/min and it expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s and nozzles are inclined at 20°C to the plane of the wheel. The blade angle at the exit of the moving blade is 30°C. Neglecting friction losses in the moving blade, evaluate (i) Velocity of the steam entering the blades (ii) Power developed, (iii). Blade efficiency and (iv) Stage efficiency.	13	BT - 5	Evaluating
12.	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^{o} and the absolute discharge velocity of steam is 100 m/s in the direction 70^{o} 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.	13	BT - 4	Analysing
13.	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.	13	BT - 3	Applying
14.	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^{o}. Considering equiangular blades and neglecting blade friction, calculate for a steam flow of 0.6 kg/s, the diagram power and the diagram efficiency.	13	BT - 3	Applying
15.	Steam enters the blade row of an impulse turbine with a velocity of 600m/s at an angle of 25^{o}C to the plane of rotation of blades. The mean blade speed is 200m/s. the blade angle at the exit is 30^{o}. 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.	13	BT - 3	Applying
16.	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	13	BT - 3	Applying

	respectively. The turbine 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.			
17.	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	13	BT - 3	Applying
18.	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.	13	BT - 3	Applying

PART-C (15 Marks)				
1.	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.	13	BT - 6	Creating
2.	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.	13	BT - 5	Evaluating
3.	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.	13	BT - 5	Evaluating

4.	In a De-Laval turbine steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is 20°, the mean blade velocity is 400 m/s, the inlet and outlet angles of blades are equal. The mass of steam flowing through the turbine per hour is 1000 kg. Calculate: (i) Blade angles, (ii) Relative velocity of steam entering the blades, (iii) Tangential force on the blades, (iv) Power developed (v) Blade efficiency, Take blade velocity co-efficient as 0.8.	13	BT - 5	Evaluating
5.	The blade angles of both fixed and moving blades of reaction steam turbine are 35° at the receiving tips and 20° at the discharging tips. At a certain point in the turbine, the drum diameter is 1.37 m and blade height is 127 'mm. The pressure of steam supply to a ring of fixed blades at this point is 1.25 bar and the dryness fraction is 0.925. Find the work done in next row of moving blades for 1 kg of steam at 600 rpm, the steam passing through the blades without shock. Assuming an efficiency of 85% for the pair of rings of fixed an moving blades, find the heat drop in the pair and state the properties of steam at the entrance to the next row of fixed blades.	13	BT - 5	Evaluating

UNIT IV PSYCHROMETRY

PART-A (2 Marks)

Psychometric and psychometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling

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	Analyse sensible heat factor at different conditions.		BT-4	Analyze
15	What do you understand by Dew Point Temperature?		BT-1	Remembering
16	Illustrate the need of psychometric process.		BT-1	Remembering
17	What is sensible heating?		BT-1	Remembering
18	Define degree of saturation.		BT-1	Remembering
19	Sketch the Cooling and dehumidifying process on a skeleton Psychometric chart.		BT-2	Understanding
20	Describe comfort zone.		BT-2	Understanding
21	Define Dry bulb Temperature.		BT-1	Remembering
22	Define Wet bulb Depression.		BT-1	Remembering
23	What is adiabatic humidification of air?		BT-1	Remembering
24	Define effective temperature (ET).		BT-1	Remembering
25	What is comfort chart?		BT-1	Remembering
PART-B (13 Marks)				
S.NO	**QUESTIONS**		**LEVEL**	**COMPETENCE**
1	Define psychrometric process. Explain various psychrometric process in detail with neat sketch.	13	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.	13	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.	13	BT-3	Applying
4.	(i) Classify various Psychometric process and their significance.	4	BT-3	Applying
	(ii) One kg of air at 40˚C dry bulb temperature and 50% RH is mixed with 2kg of air at 20˚C DBT and 20˚C dew point temperature. Calculate the temperature and specific humidity of the mixture.	9	BT-6	Creating
5.	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 final relative humidity?	13	BT-3	Applying
6.	(i) Briefly discuss about evaporative cooling process.	6	BT-4	Analysing
	(ii) Explain adiabatic saturation process with a schematic.	7		
7.	120 m^3 of air per minute at 35°C DBT and 50% relative humidity is cooled to 20°C DBT by passing through cooling coil. Determine the following i. Relative humidity of out coming air and its WBT. ii. Capacity of cooling coils in tones of refrigeration. iii. Amount of water vapor removed per hour.	13	BT-5	Evaluating
8.	(i) Derive the sensible heat factor for cooling and dehumidification process. Also explain the process.	6	BT-4	Analyzing
	(ii) One kg of air at 40°C DBT and 50% RH is mixed with 2 Kg of air at 20°C DBT and 20°C dew point temperature. Calculate the temperature and specific humidity of the mixture.	7	BT-3	Applying
9.	It is required to design an air conditioning system for an industrial process for the following hot and wet summer conditions			

	Outdoor conditions : 32°C DBT and 65% RH Required air inlet conditions: 25°C DBT and 60% RH Amount of free air circulated: 20 m^3/min Coil dew temperature : 13°C The required conditions are achieved by first cooling and dehumidifying and then by heating. Calculate the following (by psychometric chart) (i)The cooling capacity of the cooling coil and its bypass factor. (ii)Heating capacity of the heating coil in kW and surface temperature of the heating coil if the bypass factor is 0.3. The mass of the water vapor removed per hour.	13	BT-5	Evaluating
10	An air water vapor mixture enters an air conditioning unit at pressure of 1.0 bar 38°C DBT, and a relative humidity of 75%. The mass of dry air entering is 1Kg/s. The air-vapour mixture leaves the air conditioning unit at 1 bar, 18°C, 85% relative humidity. The moisture condensed leaves at 18°. Determine the heat transfer rate for the process	13	BT-3	Applying
11	200 m^3 of air per minute at 15ºC DBT and 75% R.H. is heated until its temperature is 25ºC. Find: (i) R.H. of heated air. (ii) Wet bulb temperature of heated air. (iii) Heat added to air per minute.	13	BT-3	Applying
12	Saturated air at 3ºC is required to be supplied to a room where the temperature must be held at 22ºC with a relative humidity of 55%. The air is heated and then water at 10ºC is sprayed to give the required humidity. Determine: (i) The mass of spray water required per m3 of air at room conditions. (ii) The temperature to which the air must be heated. Neglect the fan power. Assume that the total pressure is constant at 1.0132 bar	13	BT-3	Applying
13.	150 m^3 of air per minute is passed through the adiabatic humidifier. The condition of air at inlet is 35°C DBT and 20 per cent relative humidity and the outlet condition is 20°C DBT and 15°C WBT. Determine the following: (i) Dew point temperature	13	BT-5	Evaluating

	(ii) Relative humidity of the exit air (iii) Amount of water vapor added to the air per minute.			
14.	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.	13	BT-5	Evaluating
15.	A sling psychometric reads 40°C DBT and 36°C WBT. Find the humidity ratio, relative humidity, DPT, specific volume of air, density of air, density of water vapor and enthalpy.	13	BT-5	Evaluating
16.	Saturated air at 21°C 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 21°C 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.	13	BT-5	Evaluating
17.	40 m^3 of air per minute at 31°C DBT and 18.5°C WBT is passed over the cooling coil whose surface temperature is 4.4°C. 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.	13	BT-5	Evaluating
18.	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.	13	BT-5	Evaluating
PART-C (15 Marks)				
1	An air-water vapor mixture enters an air-conditioning unit at a pressure of 1.0 bar. 38˚C DBT, and a relative humidity of 75%. The mass of dry air entering is 1kg/s. The air-vapor mixture leaves the air-conditioning unit at 1.0 bar, 18˚C, 85% relative humidity. The moisture condensed leaves at 18˚C. Sketch the process in the Psychometric chart and determine the heat transfer rate for the process.	15	BT-6	Creating

2	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.	15	BT-6	Creating
3	Explain the practical application of the adiabatic mixing of two streams and derive the expression for mass ratio.	15	BT-3	Applying
4	The following data pertain to an air-conditioning system: Unconditioned space DBT =30˚C Unconditioned space WBT=22˚C Cold air duct supply surface temperature = 14˚C Determine (i) Dew point temperature (ii) Whether or not condensation will form on the duct.	15	BT-6	Creating
5.	An office is to be air-conditioned for 50 staff when the outdoor conditions are 30°C DBT and 75% RH if the quantity of air supplied is 0.4m^3 /min/person, find the following: (i) Capacity of the cooling coil in tonnes of refrigeration (ii) Capacity of the heating coil in kW (iii) Amount of water vapor removed per hour Assume that required air inlet conditions are 20°C DBT and 60% RH, Air is conditioned first by cooling and dehumidifying and then by heating. (iv) If the heating coil surface temperature is 25°C, find the by-pass factor of the heating coil?	15	BT-5	Evaluating

UNIT V - REFRIGERATION AND AIR – CONDITIONING

Vapor compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapor absorption system- Alternate refrigerants - Air conditioning system: Types, Working Principles Cooling Load calculations -Concept of RSHF, GSHF, ESHF.

PART-A (2 Marks)

S.NO	QUESTIONS	LEVEL	COMPETENCE
1	Define refrigeration effect.	BT-1	Remembering
2	Draw the Electrolux refrigeration system.	BT-2	Understanding
3	Discuss the working principle of air cycle.	BT-2	Understanding
4	What is the function of the throttling valve in vapour compression refrigeration system?	BT-1	Remembering
5	Write down four important properties of a good refrigerant.	BT-2	Understanding

6	Define super heating.		BT-1	Remembering
7	Illustrate the necessity of refrigeration.		BT-3	Applying
8	Estimate the effect of super heat and sub cooling on the vapour compression cycle.		BT-5	Evaluating
9	Compare vapor compression and vapor absorption system		BT-5	Evaluating
10	Point out the unit of refrigeration, with an example.		BT-3	Applying
11	Evaluate the functions of Cooling load calculations.		BT-5	Evaluating
12	Define thermoelectric refrigeration. .		BT-1	Remembering
13	Compare RSHF, GSHF and ESHF.		BT-3	Applying
14	Define GSHF.		BT-1	Remembering
15	Define RSHF.		BT-1	Remembering
16	Define ESHF.		BT-1	Remembering
17	Give the concept of cooling towers.		BT-2	Understanding
18	Name the types of cooling towers.		BT-2	Understanding
19	How are air-conditioning systems classified?		BT-2	Understanding
20	Point out the various sources of heat gain of an air-conditioned space.		BT-2	Understanding
21	Explain unit of refrigeration.		BT-3	Applying
22	Define COP.		BT-1	Remembering
23	Differentiate between refrigeration & air conditioning.		BT-2	Understanding
24	What are the properties of good refrigerants?		BT-1	Remembering
25	What is meant by sub-cooling?		BT-1	Remembering
PART-B (13 Marks)				
1.	Explain the working of a simple vapor compression refrigeration system with neat diagram.	13	BT-4	Analyzing
2.	A refrigerating machine using R-12 as refrigerant operates between the pressures 2.5 bar and 9.0 bar. The compression is isentropic and there is not under cooling in the condenser. The vapor is dry and saturated condition at the beginning of the compression. Estimate the	13	BT-3	Applying

	theoretical COP. If the actual COP is 0.65 of theoretical COP, calculate the net cooling produced per hour. The refrigerant flow is 5Kg/min. The Properties of Refrigerant are:			

Pressure (Bar)	Satu. temp. (C)	Enthalpy (kJ/kg)		Entropy (kJ/kg K)
9.0	36	70.55	201.8	0.6836
2.5	-7	29.62	184.5	0.7001

Take specific heat of superheated vapour at 9 bar as 0.64 kJ/kg K.

3.	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.	13	BT-4	Analyzing
4.	A cold storage room has walls made of 0.23 m of brick on the outside, 0.08 m of plastic foam and finally 15 mm of wood on the inside. The outside and inside temperature is 22ºC and 2ºC respectively. If the inside and outside heat transfer coefficient is 29 and 12 W/m^2 K respectively the thermal conductivities of bricks, foam and wood are 0.98, 0.02 and 0.17 W/m K respectively. Determine rate of heat removal by refrigeration per unit area of wall.	13	BT-5	Evaluating
5.	Air at 25 ºC WBT 25% RH is to be conditioned to 22 º C. DBT and 11 gm / kg specific humidity. Determine heat transfer per kg of dry air referring the psychometric chart. Represent the process on chart by sketch.	13	BT-3	Applying
6.	cycle. (b) If the cycle is absorbing 1130 kJ/min at 270 K, how many kJ of work is required per second. (c) If the Carnot heat pump operates between the same temperatures as the above refrigeration cycle, what is the coefficient of performance. (d) How many kJ/min will the heat pump deliver at 300 K if it absorbs 1130 kJ/min at 270 K.	13	BT-5	Evaluating
7.	The capacity of a refrigerator is 200 TR when working between –6°C and 25ºC. 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.	13	BT-5	Evaluating
8.	Five hundred kg of fruits are supplied to a cold storage at 20ºC. The 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	BT-4	Analyzing
9.	A cold storage plant is required to store 20 tons of fish. The fish is supplied at a temperature of 30°C. The specific heat of fish above freezing point is2.93 kJ/kg K. The specific heat offish below freezing point is 1.26 kJ/kg K. The fish is stored in cold storage which is maintained at –8ºC. The freezing point of fish is –4°C. The latent heat of fish is 235 kJ/kg. If the plant requires 75Kwto drive it, find(a)The capacity of the plant, and (b)Time taken to achieve cooling. Assume actual C.O.P. of the plant as 0.3 of the Carnot C.O.P.	13	BT-5	Evaluating
10.	Explain the following Counter flow induced draft; Counter flow forced draft and Cross flow induced draft.	13	BT-5	Evaluating
11.	Illustrate the factors affecting cooling tower performance in detail.	13	BT-3	Applying
12.	Illustrate the efficient system operation in cooling towers.	13	BT-3	Applying
13.	Elaborate the flow control strategies used in fans of cooling tower.	13	BT-3	Applying
14.	Explain the concept of RSHF, GSHF and ESHF, with suitable examples.	13	BT-4	Analyzing
15.	A refrigeration system of 10.5 tones capacity at an evaporator temperature of -12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant ammonia is sub cooled by 6°C before entering the expansion valve. The vapor is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type. Find (i) Condition of vapor at the outlet of the compressor (ii) Condition of vapor at the entrance of the evaporator (iii) COP and (iv) The power required. Neglect valve throttling and clearance effect.	13	BT-5	Evaluating
16.	A Freon-12 refrigerator producing a cooling effect of 20 kJ/s operates on a simple vapor compression cycle with pressure limits of 1.509 bar and 9.607 bar. The vapor leaves the evaporator dry saturated and there			

	is no under cooling. Determine the power required by the machine.	13	BT-5	Evaluating
17.	A simple saturation refrigeration cycle developing 15 tons of refrigeration using R12 operates with a condensing temperature of 35°C and an evaporator temperature of - 6°C. Calculate: (i) The refrigerating effect, (ii) Refrigerant flow rate, (iii) The power required to drive the compressor, (iv) COP.	13	BT-5	Evaluating
18.	Exp1ain summer Air Conditioning with a neat layout.	13	BT-4	Analyzing
PART-C (15 Marks)				
1.	Explain about Cooling load calculations in refrigeration and air-conditioning systems.	15	BT-4	Analyzing
2.	Generalize the effect of superheat and sub-cooling in refrigeration and air-conditioning systems.	15	BT-6	Creating
3.	Explain unitary and central air conditioning systems and their application in contemporary industries.	15	BT-5	Evaluating
4.	Exp1ain summer Air Conditioning with a neat layout.	15	BT-5	Evaluating
5.	With a neat sketch, discuss briefly the ammonia absorption refrigeration cycle	15	BT-5	Evaluating