SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur– 603203.

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

IV SEMESTER

ME3466 THERMAL ENGINEERING

Regulation–2023

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Prepared by

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SRM VALLIAMMAI ENGINEERING COLLEGE

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DEPARTMENT OF MECHANICAL ENGINEERING

ME3466 THERMAL ENGINEERING

UNIT I – BASIC STEAM POWER CYCLES
Carnot Cycle - Rankine Cycle - Modified Rankine Cycle - Regenerative Cycle - Reheat Cycle.

PART - A (2 Marks)

Q.No.	Questions	Bloom's Taxonomy Level	Competence
1.	Define Carnot cycle.	BTL-1	Remember
2.	List the processes of the Carnot vapor cycle.	BTL-1	Remember
3.	State the limitation of Carnot cycle in practical applications.	BTL-2	Understand
4.	Define Rankine cycle.	BTL-1	Remember
5.	List the main components of a Rankine cycle.	BTL-1	Remember
6.	Mention the processes involved in a Rankine cycle.	BTL-1	Remember
7.	Why is Rankine cycle preferred over Carnot cycle?	BTL-2	Understand
8.	Define modified Rankine cycle.	BTL-1	Remember
9.	State the advantage of superheating in modified Rankine cycle.	BTL-2	Understand
10.	What is regenerative cycle?	BTL-1	Remember
11.	State the purpose of feed water heating in regenerative cycle.	BTL-2	Understand
12.	Define regeneration in steam power plants.	BTL-1	Remember
13.	What is reheat cycle?	BTL-1	Remember
14.	State the advantage of reheat cycle.	BTL-2	Understand

15.	Why is reheating used in large power plants?	BTL-2	Understand
16.	Define thermal efficiency of Rankine cycle.	BTL-1	Remember
17.	How does regeneration affect thermal efficiency?	BTL-2	Understand
18.	What is meant by moisture content of steam?	BTL-1	Remember
19.	Why should moisture content at turbine exit be low?	BTL-2	Understand
20.	List any two methods of improving Rankine cycle efficiency.	BTL-1	Remember
21.	What is the role of condenser in Rankine cycle?	BTL-1	Remember
22.	Why is pump work negligible in Rankine cycle?	BTL-2	Understand
23.	Define boiler in steam power plant.	BTL-1	Remember
24.	Compare Rankine and reheat cycles in terms of efficiency.	BTL-2	Understand
25.	State one limitation of regenerative cycle.	BTL-2	Understand

Q.No.	**Questions**	**Marks**	**Bloom's Taxonomy Level**	**Competence**
1.	Explain the Carnot cycle with a neat T–s diagram and derive an expression for its thermal efficiency. Discuss its practical limitations.	16	BTL-3	Apply
2.	With a neat schematic and T–s diagram, explain the Rankine cycle. Derive expressions for work done and thermal efficiency.	16	BTL-3	Apply
3.	Compare Carnot cycle and Rankine cycle with respect to processes, efficiency, and practical applicability.	16	BTL-4	Analyze
4.	Explain the modified Rankine cycle with superheating. Show how superheating improves the efficiency and turbine performance.	16	BTL-4	Analyze

5.	Derive the expression for thermal efficiency of a simple Rankine cycle and discuss the factors affecting it.	16	BTL-4	Analyze
6.	Explain the regenerative Rankine cycle with a neat diagram. Discuss the effect of regeneration on thermal efficiency.	16	BTL-4	Analyze
7.	With the help of T–s diagrams, analyze a Rankine cycle with one open feedwater heater.	16	BTL-4	Analyze
8.	Compare simple Rankine cycle and regenerative cycle in terms of efficiency, work output, and fuel economy.	16	BTL-4	Analyze
9.	Explain the reheat Rankine cycle with neat sketches. Discuss its advantages and limitations.	16	BTL-4	Analyze
10.	Explain with the help of neat diagram a 'Regenerative Cycle'. Derive also an expression for its thermal efficiency.	16	BTL-3	Apply
11.	A steam boiler generates steam at 30 bar, 300ºC at the rate of 2 kg/s. This steam is expanded isentropically in a turbine to a condenser pressure of 0.05 bar, condensed at constant pressure and pumped back to boiler. a. Draw the schematic arrangement of the above plant and T-s diagram of Rankine cycle. b. Find the heat supplied in the boiler per hour. c. Determine the quality of steam after expansion. d. What is the power generated by the turbine? e. Estimate the Rankine cycle efficiency considering pimp work.	16	BTL-4	Analyze
12.	In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. The flow rate of	16	BTL-4	Analyze

	steam 9.5 kg/s. Determine the (1) Pump work (2) turbine work (3) Rankine efficiency (4) condenser heat flow (5) work ratio and (6) specific steam consumption.			
13.	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. Find the: a. Quality of steam at turbine exhaust b. Cycle efficiency c. Steam rate in kg/kw. hr.	16	BTL-5	Evaluate
14.	A reheat Rankine cycle receives steam at 35 bar and 0.1 bar. Steam enters the first stage steam turbine 350°C. If reheating is done at 8 bar to 350°C, calculate the specific steam consumption and reheat Rankine cycle efficiency.	16	BTL-4	Analyze
15.	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	BTL-5	Evaluate
16.	Steam enters the turbine at 3 MPa and 400°C and is covered at 10 kPa. Some quantity of steam leaves the turbine at 0.6 MPa and enters	16	BTL-5	Evaluate

	open feed water heater. Compute the fraction of the steam extracted per kg of steam and cycle thermal efficiency.			
17.	In a single-heater regenerative cycle the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.1 bar. The feed water heater is a direct contact type which operates at 5 bar. Find: a. The efficiency and the steam rate of the cycle. b. The increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without Regeneration). Pump work may be neglected.	16	BTL-5	Evaluate
18.	Steam at 70 bar and 450°C is supplied to a steam turbine. After expanding to 25 bar in high pressure stages, it is expanded in intermediate pressure stages to an appropriate minimum pressure such that part of the steam bled at this pressure heats the feed water to a temperature of 180°C. the remaining steam expands from this pressure to a condenser pressure of 0.07 bar in the low pressure stage. The isentropic efficiency of H.P. stage is 78.5%, while that of the intermediate and L.P. stages is 83% each. From the above data, determine: a. The minimum pressure at which bleeding is necessary. b. The quantity of steam bled per kg of flow at the turbine inlet. c. The cycle efficiency. Neglect pump work.	16	BTL-5	Evaluate

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)

Q.No.	Questions	Bloom's Taxonomy Level	Competence
1.	Define air standard cycle.	BTL-1	Remember
2.	State the assumptions of air standard cycles.	BTL-1	Remember
3.	Define Otto cycle.	BTL-1	Remember
4.	List the processes of Otto cycle.	BTL-1	Remember
5.	Define Diesel cycle.	BTL-1	Remember
6.	List the processes of Diesel cycle.	BTL-1	Remember
7.	Define Dual cycle.	BTL-1	Remember
8.	Why is Dual cycle considered more practical?	BTL-2	Understand
9.	Define mean effective pressure (MEP).	BTL-1	Remember
10.	State the significance of mean effective pressure.	BTL-2	Understand
11.	Write the expression for air standard efficiency of Otto cycle.	BTL-1	Remember
12.	How does compression ratio affect Otto cycle efficiency?	BTL-2	Understand
13.	Write the expression for air standard efficiency of Diesel cycle.	BTL-1	Remember
14.	Compare Otto and Diesel cycles based on efficiency.	BTL-2	Understand
15.	Define cut-off ratio.	BTL-1	Remember
16.	How does cut-off ratio affect Diesel cycle efficiency?	BTL-2	Understand

17.	Write the expression for air standard efficiency of Dual cycle.	BTL-1	Remember
18.	Compare Otto and Dual cycles.	BTL-2	Understand
19.	What is specific heat ratio (γ)?	BTL-1	Remember
20.	Why is γ important in air standard cycle analysis?	BTL-2	Understand
21.	Define swept volume.	BTL-1	Remember
22.	What is clearance volume?	BTL-1	Remember
23.	How is mean effective pressure related to work output?	BTL-2	Understand
24.	State two applications of air standard cycle analysis.	BTL-1	Remember
25.	Compare efficiencies of Otto, Diesel, and Dual cycles.	BTL-2	Understand

PART - B (16 Marks)

Q.No.	Questions	Marks	Bloom's Taxonomy Level	Competence
1.	Explain "Air standard analysis" which has been adopted for IC engine cycles. State the assumptions made for air standard cycles.	16	BTL-3	Apply
2.	Derive an expression for the air standard efficiency of an Otto cycle.	16	BTL-3	Apply
3.	Derive an expression for the mean effective pressure of Otto cycle.	16	BTL-3	Apply
4.	Derive an expression for the air standard efficiency of an Diesel cycle. Explain why the efficiency of an Otto cycle is more than Diesel cycle for the same compression ratio.	16	BTL-4	Analyze
5.	Derive an expression for the mean effective pressure of Diesel cycle in terms of cut-off ratio and compression ratio.	16	BTL-3	Apply
6.	Derive an expression for the air standard efficiency of a Dual cycle.	16	BTL-3	Apply

7.	Derive an expression for the mean effective pressure of Dual cycle.	16	BTL-3	Apply
8.	What are the differences between Otto, Diesel and Dual combustion cycles.	16	BTL-4	Analyze
9.	Compare Otto, Diesel, and Dual combustion cycles.	16	BTL-4	Analyze
10.	A gas engine operating on the ideal Otto cycle has a compression ratio of 6:1. The pressure and temperature of the commencement of compression are 1 bar and 27°C. Heat added during the constant volume combustion process is 1170 kJ/kg. Determine the peak pressure and temperature, work output per kg of air and air standard efficiency. Assume C_p = 1.004 kJ/kg. K, C_v = 0.717 kJ/kg. K and γ = 1 for air.	16	BTL-4	Analyze
11.	In an Otto cycle air at 17°C and 1 bar is compressed adiabatically until the pressure is 15 bar. Heat is added at constant volume until the pressure rises to 40 bar. Calculate the air-standard efficiency, compression ratio and mean effective pressure for the cycle. Assume C_v = 0.717 kJ/kg K and R = 8.314 kJ/kmol K.	16	BTL-4	Analyze
12.	An engine of 250 mm, bore and 375 mm stroke works on 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, find the following: a. The air standard efficiency of the cycle. b. The mean effective pressure for the cycle. Assume the ideal conditions.	16	BTL-4	Analyze

13.	For the air standard Diesel cycle, the following data is available compression ratio 18, heat added 2000 kJ/kg. lowest temperature in the cycle is 300 K. Lowest pressure in the cycle 1 bar. Calculate the pressure and temperature at each point in the cycle. Assume C_p= 1 kJ/kg K. and C_v= 0.714 kJ/kg K.	16	BTL-4	Analyze
14.	For an ideal Diesel engine, operating an air standard with γ = 1.4, determine the thermal efficiency for cut-off ratios of 1.25, 1.50 and 2.0. Compression ratio is 16.	16	BTL-5	Evaluate
15.	An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. the cut-off is 8% of the stroke. Determine: a. Pressures and temperatures at all salient points. b. Theoretical air standard efficiency. c. Mean effective pressure. d. Power of the engine if the working cycles per minute are 380. Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.	16	BTL-5	Evaluate
16.	An engine working on a dual cycle, the temperature and pressure at the beginning of the cycle are 90°C and 1 bar. The compression ratio is 9. The maximum pressure is limited to 68 bar and total heat supplied per kg of air is 1750 kJ. Determine the air standard efficiency and mean effective pressure.	16	BTL-4	Analyze

17.	The swept volume of a Diesel engine working on dual cycle is 0.0053 m^3 and clearance volume is 0.00035 m^3. The maximum pressure is 65 bar. Fuel injection ends at 5 per cent of the stroke. The temperature and pressure at the start of the compression are 80°C and 0.9 bar. Determine the air standard efficiency of the cycle. Take γ for air = 1.4.	16	BTL-5	Evaluate
18.	A Diesel engine working on a dual combustion cycle has a stroke volume of 0.0085 m^3 and a compression ratio 15:1. The fuel has a calorific value of 43890 kJ/kg. At the end of suction, the air is at 1 bar and 100°C. the maximum pressure in the cycle is 65 bar and air fuel ratio is 21:1. Find for ideal cycle the thermal efficiency. Assume C_p = 1.0 and C_v = 0.71.	16	BTL-5	Evaluate

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)

Q.No.	Questions	Bloom's Taxonomy Level	Competence
1.	Define an internal combustion engine.	BTL-1	Remember
2.	Classify IC engines based on number of strokes.	BTL-1	Remember
3.	Classify IC engines based on method of ignition.	BTL-1	Remember
4.	State two applications of SI engines.	BTL-1	Remember
5.	State two applications of CI engines	BTL-1	Remember
6.	What is valve timing diagram?	BTL-1	Remember
7.	Differentiate theoretical and actual valve timing diagrams.	BTL-2	Understand
8.	Why are inlet and exhaust valves opened early in actual valve timing?	BTL-2	Understand
9.	What is port timing diagram?	BTL-1	Remember
10.	Why is port timing diagram important?	BTL-2	Understand
11.	What is p-V diagram?	BTL-1	Remember
12.	State the significance of p-V diagram.	BTL-2	Understand
13.	List the processes in a four-stroke Otto cycle engine.	BTL-1	Remember
14.	List the processes in a four-stroke Diesel cycle engine.	BTL-1	Remember
15.	Compare theoretical and actual p-V diagrams of IC engines.	BTL-2	Understand
16.	Define indicated power.	BTL-1	Remember

17.	Define brake power.	BTL-1	Remember
18.	What is mechanical efficiency?	BTL-1	Remember
19.	Define thermal efficiency.	BTL-1	Remember
20.	Differentiate indicated thermal efficiency and brake thermal efficiency.	BTL-2	Understand
21.	What is specific fuel consumption?	BTL-1	Remember
22.	State the significance of brake specific fuel consumption.	BTL-2	Understand
23.	What is mean effective pressure?	BTL-1	Remember
24.	How is mean effective pressure useful?	BTL-2	Understand
25.	Define volumetric efficiency.	BTL-1	Remember

PART - B (16 Marks)

Q.No.	Questions	Marks	Bloom's Taxonomy Level	Competence
1.	With a suitable diagram illustrate the construction details of IC engine.	16	BTL-3	Apply
2.	Describe briefly and with appropriate sketches, the actual sequence of events in the cylinder of a petrol engine working on the four-stroke cycle.	16	BTL-3	Apply
3.	Discuss the working of a two-stroke cycle petrol engine with the help of neat sketches.	16	BTL-3	Apply
4.	Draw the theoretical valve timing diagram of a four-stroke IC engine and apply it to explain the sequence of valve operations. Compare it with an actual valve timing diagram and justify the need for valve timing advance and retard.	16	BTL-4	Analyze
5.	Draw and explain the port timing diagram of a two-stroke IC engine. Apply the diagram to describe the sequence of port opening and	16	BTL-4	Analyze

	closing and explain how it affects charging and scavenging processes.			
6.	Draw the theoretical and actual p–V diagrams of a four-stroke Otto cycle engine. Apply these diagrams to explain the deviations between ideal and actual cycles and their impact on engine performance	16	BTL-4	Analyze
7.	With neat p–V diagrams, analyze the theoretical and actual cycles of four-stroke Otto and Diesel engines. Compare the losses involved and explain how real engine processes differ from ideal cycles.	16	BTL-4	Analyze
8.	Distinguish between petrol and Diesel engines.	16	BTL-4	Analyze
9.	Write down the advantages and disadvantages of two-stroke over four-stroke cycle engines.	16	BTL-3	Apply
10.	List the various tests performed for measuring friction power of an IC engine. Explain any two methods in detail.	16	BTL-3	Apply
11.	Explain in detail about the Morse test and write the procedure in detail.	16	BTL-3	Apply
12.	How the heat balance test is conducted in an IC engine? Prepare a model heat balance sheet for an IC engine.	16	BTL-4	Analyze
13.	What is retardation test? And explain in detail.	16	BTL-3	Apply
14.	A 4-cylinder, four-stroke cycle engine, 82.5 mm bore *X* 130 mm stroke develops 28 kW while running at 1500 r.p.m. and using a 20 per cent rich mixture. If the volume of the air in the cylinder when measured at 15.5°C and 762 mm of mercury is 70 per cent of the swept volume, the theoretical air-fuel ratio is 14.8, heating value of petrol used is 45980 kJ/kg and the	16	BTL-4	Analyze

	mechanical efficiency of the engine is 90%, find: a. The indicated thermal efficiency b. The brake mean effective pressure. Take R = 287 Nm/kg K.			
15.	A four stroke diesel engine has a piston diameter of 16.5 cm and a stroke of 27 cm. the compression ratio is 14.3, the cut-off a 4.23% of the stroke and mean effective pressure 4.12 bar. The engine speed is 264 rpm and the fuel consumption is 1.076 kg of oil per hour, having a calorific value of 39150 kJ/kg. Calculate the relative efficiency of the engine.	16	BTL-5	Evaluate
16.	A 4-cylinder petrol engine has a bore of 60 mm and a stroke of 90 mm. its rated speed is 2800 r.p.m. 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 litres/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 in the order 1,2,3,4 with corresponding brake loads of 110, 107, 104 and 110 N respectively. Calculate for this speed: a. The engine torque, b. The brake mean effective pressure, c. The brake thermal efficiency, d. The specific fuel consumption, e. Mechanical efficiency, and f. Indicated mean effective pressure.	16	BTL-5	Evaluate
17.	In a test of an oil engine under full load condition the following results were obtained. Indicated Power (IP) = 33 kW	16	BTL-5	Evaluate

<table>
<tr>
<td></td>
<td>Brake Power (BP) = 27 kW
Fuel used = 8 kg/hr
Rate of flow of water through gas calorimeter = 12 kg/min
Cooling water flow rate = 7 kg/min
Calorific value of the fuel (CV) = 43 MJ/kg
Inlet temperature of cooling water = 15°C
Outlet temperature of cooling water = 75°C
Inlet temperature of water to exhaust gas calorimeter = 15°C
Outlet temperature of water to exhaust gas calorimeter = 55°C
Final temperature of the exhaust gases = 80°C
Room temperature = 17°C
Air-Fuel ratio on mass basis = 20
Mean specific heat of exhaust gas = 1 kJ/g. K
Specific heat of water = 4.18 kJ/kg. K
Draw a heat balance sheet and estimate the thermal and mechanical efficiencies.</td>
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<td>18.</td>
<td>A Morse test on a 12 cylinder two-stroke compression-ignition engine of bore 40 cm and stroke 50 cm running at 200 rpm gave the following readings:
<table>
<tr><th>Condition</th><th>Brake Load (Newton)</th><th>Condition</th><th>Brake Load (Newton)</th></tr>
<tr><td>All Firing</td><td>2040</td><td>7th Cylinder</td><td>1835</td></tr>
<tr><td>1st Cylinder</td><td>1830</td><td>8th Cylinder</td><td>1860</td></tr>
<tr><td>2nd Cylinder</td><td>1850</td><td>9th Cylinder</td><td>1820</td></tr>
<tr><td>3rd Cylinder</td><td>1850</td><td>10th Cylinder</td><td>1840</td></tr>
<tr><td>4th Cylinder</td><td>1830</td><td>11th Cylinder</td><td>1850</td></tr>
<tr><td>5th Cylinder</td><td>1840</td><td>12th Cylinder</td><td>1830</td></tr>
</table>
</td>
<td>16</td>
<td>BTL-5</td>
<td>Evaluate</td>
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	<table><tr><td>6th Cylinder</td><td>1855</td><td>All Firing</td><td>2060</td></tr></table> The output is found from the dynamometer using the relation. $$BP = \frac{W.N}{180}$$ Where W, the brake load is in Newton and the speed, N is in rpm. Calculate IP, Mechanical Efficiency and BMEP of the engine.			

UNIT IV – STEAM NOZZLES AND STEAM TURBINES

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.

PART - A (2 Marks)

Q.No.	Questions	Bloom's Taxonomy Level	Competence
1.	Define a steam turbine.	BTL-1	Remember
2.	State the principle of operation of a steam turbine.	BTL-1	Remember
3.	What is meant by steam nozzle?	BTL-1	Remember
4.	State the function of a steam nozzle.	BTL-1	Remember
5.	Define nozzle efficiency.	BTL-1	Remember
6.	Why is nozzle efficiency always less than unity?	BTL-2	Understand
7.	Classify steam turbines based on principle of operation.	BTL-1	Remember
8.	Classify steam turbines based on direction of steam flow.	BTL-1	Remember
9.	State two advantages of steam turbine over steam engine.	BTL-1	Remember
10.	Why are steam turbines preferred for power generation?	BTL-2	Understand
11.	What is meant by compounding of steam turbines?	BTL-1	Remember
12.	State the need for compounding in steam turbines.	BTL-2	Understand
13.	What are the methods of reducing wheel speed?	BTL-1	Remember
14.	Define impulse turbine.	BTL-1	Remember
15.	State one example of impulse turbine.	BTL-1	Remember
16.	Why is pressure constant in impulse turbine blades?	BTL-2	Understand

17.	Define blade efficiency.	BTL-1	Remember
18.	Define turbine efficiency.	BTL-1	Remember
19.	List the types of turbine efficiencies.	BTL-1	Remember
20.	What is stage efficiency?	BTL-1	Remember
21.	Differentiate nozzle efficiency and blade efficiency.	BTL-2	Understand
22.	Why are impulse turbines suitable for high head applications?	BTL-2	Understand
23.	What is meant by governing of steam turbines?	BTL-1	Remember
24.	State the effect of friction in turbine blades.	BTL-2	Understand
25.	State one limitation of impulse turbine.	BTL-2	Understand

PART - B (16 Marks)

Q.No.	Questions	Marks	Bloom's Taxonomy Level	Competence
1.	Define the term "Steam Nozzle". Explain various types of nozzles and write its functions with reference to flow of steam.	16	BTL-3	Apply
2.	State the relation between the velocity of steam and heat during any part of a steam nozzle.	16	BTL-3	Apply
3.	What is steady flow energy equation as applied to steam nozzle? Explain its use in the calculation of steam velocity at the exit of a nozzle.	16	BTL-3	Apply
4.	Discuss the effect of friction on the flow through a steam nozzle. Explain with the help of h-s diagram.	16	BTL-4	Analyze
5.	What do you mean by supersaturated flow? Explain with the help of h-s diagram.	16	BTL-4	Analyze

6.	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%.	16	BTL-4	Analyze
7.	Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2.0 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, find the percentage reduction in the final velocity.	16	BTL-5	Evaluate
8.	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: a. The exit velocity of steam b. Ratio of cross-section at exit and that at throat. Assume the index of adiabatic expansion to be 1.135.	16	BTL-4	Analyze
9.	(i) What are the important considerations for selection of the blade material for a steam turbine?	6	BTL-3	Apply
	(ii) A convergent-divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 6.9 bar and $180^{o}C$ 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	10	BTL-3	Apply

	equivalent to 62.76 kJ/kg of steam. Taking approach velocity of 75 m/s and throat pressure 3,9 bar, estimate: a. Suitable area for the throat and exit. b. Overall efficiency of the nozzle base on the enthalpy drop between the actual inlet pressure, and temperature and the exit of the pressure.			
10.	Define a steam turbine and state its fields of application and how are the steam turbines classified?	16	BTL-3	Apply
11.	Explain with help of neat sketch a single-stage impulse turbine. Also explain the pressure and velocity variations along the axial direction.	16	BTL-3	Apply
12.	Explain the pressure compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine.	16	BTL-4	Analyze
13.	Explain the velocity compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine.	16	BTL-4	Analyze
14.	Define two-stage impulse turbine. How will you draw the combined velocity triangle for such a turbine?	16	BTL-3	Apply
15.	The velocity of steam existing 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^{o}. considering equiangular blades and neglecting blade friction, calculate for a	16	BTL-5	Evaluate

	steam flow of 0.6 kg/s. the diagram power and the diagram efficiency.			
16.	A single stage steam turbine is supplied with steam at 5 bar, 200°C at the rate of 50 kg/min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. the nozzles are inclined at an angle of 20° to the plane of the wheel and the outlet blade angle is 30°. Neglecting friction losses, determine the power developed, blade efficiency, and stage efficiency.	16	BTL-5	Evaluate
17.	In a stage of impulse reaction turbine provided with single row wheel, the mean diameter of the blades in 1 m. It runs at 3000 r.p.m. The steam issues from the nozzle at a velocity of 350 m/s and the nozzle angle is 20°. The rotor blades are equiangular. The blade friction factor is 0.86. Determine the power developed if the axial thrust on the end bearing of a rotor is 118 N.	16	BTL-5	Evaluate
18.	Ina single stage impulse turbine the mean diameter of the blade ring is 1 metre and the rotational speed is 3000 r.p.m. The steam is issued from the nozzle at 300 m/s and nozzle angle is 20°. The blades are equiangular. If the friction loss in the blade channel is 19% of the kinetic energy corresponding to the relative velocity at the inlet to the blades, what is the power developed in the blading when the axial thrust on the blades is 98 N.	16	BTL-5	Evaluate

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)

Q.No.	Questions	Bloom's Taxonomy Level	Competence
1.	Define psychrometry.	BTL-1	Remember
2.	What is psychrometrics?	BTL-1	Remember
3.	Define dry bulb temperature.	BTL-1	Remember
4.	Define wet bulb temperature.	BTL-1	Remember
5.	What is relative humidity?	BTL-1	Remember
6.	Define specific humidity.	BTL-1	Remember
7.	What is dew point temperature?	BTL-1	Remember
8.	State the use of psychrometric chart.	BTL-2	Understand
9.	What are psychrometric processes?	BTL-1	Remember
10.	State two common psychrometric processes	BTL-1	Remember
11.	Define refrigeration.	BTL-1	Remember
12.	What is meant by ton of refrigeration?	BTL-1	Remember
13.	Define coefficient of performance (COP).	BTL-1	Remember
14.	Why is COP preferred over efficiency in refrigeration?	BTL-2	Understand
15.	What is air refrigeration system?	BTL-1	Remember
16.	State one application of air refrigeration system.	BTL-1	Remember
17.	Define vapour compression refrigeration system.	BTL-1	Remember
18.	List the main components of vapour compression system.	BTL-1	Remember

19.	State the function of evaporator.	BTL-1	Remember
20.	State the function of condenser.	BTL-1	Remember
21.	What is vapour absorption refrigeration system?	BTL-1	Remember
22.	Name the refrigerant-absorbent pair used in VARS.	BTL-1	Remember
23.	State one advantage of vapour absorption system.	BTL-2	Understand
24.	Compare vapour compression and vapour absorption systems.	BTL-2	Understand
25.	State one application of vapour absorption system.	BTL-1	Remember

PART - B (16 Marks)

Q.No.		Questions	Marks	Bloom's Taxonomy Level	Competence
1.	(i)	What do you understand by the term 'psychrometry' and 'psychrometrics'.	6	BTL-3	Apply
	(ii)	Explain the following terms: a. Dew point temperature (DPT) b. Dew point depression c. Specific Humidity (SH) d. Relative Humidity (RH) e. Enthalpy	10	BTL-3	Apply
2.		Draw a skeleton psychrometric chart and explain the various terms involved in the process.	16	BTL-3	Apply
3.		Explain briefly with a neat sketch a 'sling psychrometer' and write its use.	16	BTL-3	Apply
4.		Describe the following processes: a. Sensible heating b. Cooling and dehumidification c. Heating and humidification d. Heating and dehumidification.	16	BTL-4	Analyze

5.	The atmospheric conditions are; 20oC and specific humidity of 0.0095 kg / kg of dry air. Calculate the following: a. Partial pressure of vapour b. Relative humidity c. Dew point temperature	16	BTL- 4	Analyze
6.	The sling pshchrometer in a laboratory test recorded the following readings: a. Dry bulb temperature = 35oC b. Wet bulb temperature = 25oC. c. Calculate the following: d. Specific humidity e. Relative humidity f. Vapour density n air g. Dew point temperature h. Enthalpy of mixture per kg of dry air Take atmospheric pressure = 1.0132 bar.	16	BTL- 4	Analyze
7.	40 m^3 of air at 35°C DBT and 50% R.H. is cooled to 25°C DBT maintaining its specific humidity constant. Determine: a. Relative humidity (R.H.) of cooled air; b. Heat removed from air.	16	BTL- 4	Analyze
8.	It is required to design an air-conditioning plant for a small office room for following winter conditions: Outdoor conditions….14°C DBT and 10°C WBT Required conditions….20°C DBT and 60% R.H. Amount of air circulation…0.30 m^3/min. / person. Seating capacity of office…. 60.	16	BTL-5	Evaluate

	The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following: a. Heating capacity of the coil in kW and the surface temperature required if the by-pass factor of coil is 0.4. b. The capacity of the humidifier. Solve the problem by using psychrometric chart.				
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% R.H. Required air inlet conditions….25°C DBT and 60% R.H. Amount of free air circulated….250 m^3/min. Coil dew temperature….13°C. The required conditions is achieved by first cooling and dehumidifying and then by heating. Calculate the following: a. The cooling capacity of the cooling coil and its by-pass factor. b. Heating capacity of the heating coil in kW and surface temperature of the heating coil if the by-pass factor is 0.3. The mass of water vapour removed per hour. Solve this problem with the use of psychrometric chart.		16	BTL-5	Evaluate
10.	(i)	What are the fundamentals of refrigeration system and state elements of refrigeration systems.	8	BTL-3	Apply
	(ii)	What is coefficient of performance and standard rating of a refrigeration machine?	8	BTL-3	Apply

11.	What is main characteristic feature of an air refrigeration system?	16	BTL-3	Apply
12.	With a neat sketch explain about the simple vapour compression system and write its merits and demerits.	16	BTL-3	Apply
13.	With a help of neat sketch explain about the simple vapour absorption system and write a short notes about the practical vapour absorption systems.	16	BTL-3	Apply
14.	A cold storage plant is required to store 20 tonnes of fish. The temperature of the fish when supplied = 25°C; storage temperature of fish required = -8°C; specific heat of fish above freezing point = 2.93 kJ/kg °C; specific heat of fish below freezing point = 1.25 kJ/kg °C; freezing point of fish = -3 °C. latent heat of fish = 232 kJ/kg. If the cooling is achieved within 8 hours; find out: a. Capacity of refrigeration plant. b. Carnot cycle C.O.P. between this temperature range. c. If the actual C.O.P. is 1/3rd of the Carnot C.O.P. find out the power required to run the plant.	16	BTL-5	Evaluate
15.	An air refrigeration open system operating between 1 MPa and 100 kPa is required to produce a cooling effect of 2000 kJ/min. Temperature of the air leaving the cold chamber is -5oC and at leaving the cooler is 30oC. neglect losses and clearance in the compressor and expander. Determine: a. Mass of air circulated per minute;	16	BTL-5	Evaluate

<table>
<tr><td></td><td>b. Compressor work, expander work, cycle work;
c. C.O.P. and power in kW required.</td><td></td><td></td><td></td></tr>
<tr><td>16.</td><td>In a standard vapour compression refrigeration cycle, operating between an evaporator temperature of -10oC and a condenser temperature of 40oC, the enthalpy of the refrigerant, Freon-12, at the end of compression is 220 kJ/kg. show the cycle diagram on T-s plane. Calculate:
The C.O.P. of the cycle.
The refrigeration capacity and the compressor power assuming a refrigerant flow rate of 1 kg/min. you may use the extract of Freon-12 property table given below:
<table>
<tr><td>t (^{o}C)</td><td>p (mPa)</td><td>h_f (kJ/kg)</td><td>h_g(kJ/kg)</td></tr>
<tr><td>-10</td><td>0.2191</td><td>26.85</td><td>183.1</td></tr>
<tr><td>40</td><td>0.9607</td><td>74.53</td><td>203.1</td></tr>
</table></td><td>16</td><td>BTL-5</td><td>Evaluate</td></tr>
<tr><td>17.</td><td>A refrigerator operating on standard vapour compression cycle has a co-efficiency performance of 6.5 and is driven by a 50 kW compressor. The enthalpies of saturated liquid and saturated vapour refrigerant at the operating condensing temperature of 35^{o}C are 62.55 kJ/kg and 201.45 kJ/kg respectively. The saturated refrigerant vapour leaving evaporator has an enthalpy of 187.53 kJ/kg. Find the refrigerant temperature at compressor discharge. The C_p of refrigerant vapour may be taken to be 0.6155 kJ/kg ^{o}C.</td><td>16</td><td>BTL-5</td><td>Evaluate</td></tr>
<tr><td>18.</td><td>A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of -12^{o}C and a condenser temperature of 27^{o}C is needed in a</td><td>16</td><td>BTL-5</td><td>Evaluate</td></tr>
</table>

	food storage locker. The refrigerant ammonia is sub-cooled by 6^{o}C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type. Using p-h chart find: a. Condition of volume at outlet of the compressor b. Condition of vapour at entrance to evaporator c. C.O.P. d. Power required, in kW Neglect valve throttling and clearance effect.			

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