# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad-500043

## AERONAUTICAL ENGINEERING

## TUTORIAL QUESTION BANK

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| **Course Title** | **ENGINEERING THERMODYNAMICS** | | | | |
| **Course Code** | AAEB02 | | | | |
| **Programme** | B.Tech | | | | |
| **Semester** | III | AE | | | |
| **Course Type** | Core | | | | |
| **Regulation** | **IARE - R18** | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | - | 3 | - | - |
| **Chief Coordinator** | Mr R Sabari Vihar, Assistant professor | | | | |
| **Course Faculty** | Mr R Sabari Vihar, Assistant professor<br>Mrs M. Shravani, Assistant professor | | | | |

## COURSE OBJECTIVES:

| **The course should enable the students to:** | |
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| I | Understand the laws of thermodynamics and determine thermodynamic properties, gas laws. |
| II | Apply knowledge of pure substances, mixtures, usage of steam tables and Mollier chart, psychrometric charts |
| III | Understand the direction law and concept of increase in entropy of universe. |
| IV | Understand the working of ideal air standard, vapour cycles and evaluate their performance in open systems like steam power plants, internal combustion engines, gas turbines and refrigeration systems. |
| V | Understand the basic concepts of heat transfer and working and types of heat exchangers. |

## COURSE OUTCOMES (COs):

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| CO 1 | Understand basics of thermodynamics along with basic laws of thermodynamics. |
| CO 2 | Understand the limitations of first law of thermodynamics and different forms of second law of thermodynamics. |
| CO 3 | Describe the properties of pure substances with help of phase diagrams and also understand the psychrometric properties. |
| CO 4 | Understand different processes in different standard cycles and calculate efficiencies of each cycle. |
| CO 5 | Understand working of heat exchangers, different types of heat exchangers and working of them. |

## COURSE LEARNING OUTCOMES (CLOs):

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| AAEB02.01 | Understand the basic terms and terminologies of thermodynamics along with different view point of thermodynamic systems. |
| AAEB02.02 | Get knowledge about concept of temperature and explain zeroth law of thermodynamics and also about quality of temperature. |
| AAEB02.03 | Explain about first law of thermodynamics and its various corollaries along with Joules experiment. |
| AAEB02.04 | Understand the limitations of first law of thermodynamics. |
| AAEB02.05 | Explain about thermal reservoir, heat pump, heat engine and parameters of performance. |
| AAEB02.06 | Explain second law of thermodynamics, Kelvin planck and Clausius statement of it. |
| AAEB02.07 | Understand the Kelvin planck and Clausius equivalence, corollaries and understand about perpetual motion machine one. |
| AAEB02.08 | Understand the term entropy, its principle and how it influences the availability and irreversibility of thermodynamic potentials. |
| AAEB02.09 | Understand pure substances and phase diagrams and about terms triple point and critical point. |
| AAEB02.10 | Understand how properties like wet bulb temperature, dry bulb temperature, dew bulb temperature help in building mollier chart and psychrometric chart. |
| AAEB02.11 | Determine the equilibrium states of a wide range of systems, ranging from mixtures of gases, liquids, solids and pure condensed phases that can each include multiple components. |
| AAEB02.12 | Introduction to concepts of power and refrigeration cycles. Their efficiency and coefficients of performance. |
| AAEB02.13 | Ability to use modern engineering tools, software and equipment to analyze energy transfer in required air-condition application. |
| AAEB02.14 | Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc. |
| AAEB02.15 | Understand about working of heat exchangers and different types of heat exchangers. |
| AAEB02.16 | Understand the working of gas compressors and air compressors and different types of air compressors. |

## TUTORIAL QUESTION BANK

| MODULE- I | | | | |
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| **BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS** | | | | |
| **Part - A (Short Answer Questions)** | | | | |
| **S No** | **QUESTIONS** | **Blooms Taxonomy Level** | **Course Outcomes** | **Course Learning Outcomes (CLOs)** |
| 1 | Explain Zeroth law of Thermodynamics. | Understand | CO 1 | AAEB02.01 |
| 2 | Define System, Surroundings and system boundary? | Remember | CO 1 | AAEB02.01 |
| 3 | Distinguish between macroscopic and microscopic point of view? | Remember | CO 1 | AAEB02.01 |
| 4 | Discuss Quasi Static process, what are its characteristics? | Understand | CO 1 | AAEB02.01 |
| 5 | Distinguish between different types of systems with examples. | Remember | CO 1 | AAEB02.01 |
| 6 | Explain the features of constant volume gas thermometer. | Understand | CO 1 | AAEB02.01 |
| 7 | Define Specific heat capacity at constant pressure. | Remember | CO 1 | AAEB02.01 |
| 8 | State thermodynamic system? How do you classify it? | Understand | CO 1 | AAEB02.01 |
| 9 | State the closed system? Give an example | Remember | CO 1 | AAEB02.01 |
| 10 | Define Intensive and Extensive properties. | Understand | CO 1 | AAEB02.01 |
| 11 | Define equilibrium of a system? | Remember | CO 1 | AAEB02.01 |
| 12 | Explain whether the heat and work are Intensive/Extensive properties. | Remember | CO 1 | AAEB02.01 |
| 13 | Differentiate closed and open system. | Understand | CO 1 | AAEB02.01 |

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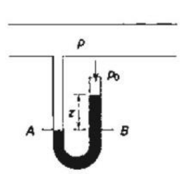
| 14 | Define Specific heat capacity at constant volume | Remember | CO 1 | AAEB02.01 |
| 15 | Differentiate closed and open system. | Understand | CO 1 | AAEB02.01 |
| 16 | Classify the properties of system? | Understand | CO 1 | AAEB02.01 |
| 17 | Discuss First law of thermodynamics. Explain Joule’s experiment. | Understand | CO 1 | AAEB02.02 |
| 18 | Define PMM 1. | Understand | CO 1 | AAEB02.02 |
| 19 | State the causes of irreversibility? | Remember | CO 1 | AAEB02.03 |
| 20 | Derive Steady Flow Energy Equation for an air compressor | Remember | CO 1 | AAEB02.03 |
| **Part - B (Long Answer Questions)** | | | | |
| 1 | Differentiate the system, surroundings and boundary. Explain in detail. | Understand | CO 1 | AAEB02.01 |
| 2 | Classify the types of systems; explain the energy exchange in them. | Remember | CO 1 | AAEB02.01 |
| 3 | Explain with an example the macroscopic and microscopic study of thermodynamics? | Remember | CO 1 | AAEB02.01 |
| 4 | Define and Explain the importance of concept of continuum in thermodynamic approach? | Understand | CO 1 | AAEB02.01 |
| 5 | Describe the Isobaric process diagrammatically on P-V? | Understand | CO 1 | AAEB02.02 |
| 6 | Explain thermodynamic equilibrium in detail? | Remember | CO 1 | AAEB02.02 |
| 7 | Differentiate thermal equilibrium and thermodynamic equilibrium with and example. | Understand | CO 1 | AAEB02.02 |
| 8 | Explain, the role of chemical equilibrium in thermodynamic equilibrium | Understand | CO 1 | AAEB02.02 |
| 9 | Describe the Isochoric process and represent on P-V diagram. | Remember | CO 1 | AAEB02.02 |
| 10 | What is displacement work? Explain about displacement work with neat diagram | Understand | CO 1 | AAEB02.03 |
| 11 | State Zeroth law of thermodynamics and explain it with a standard example? | Understand | CO 1 | AAEB02.03 |
| 12 | Explain the Joule’s experiment with a neat sketch? | Understand | CO 1 | AAEB02.03 |
| 13 | Describe the isothermal process with P-V and T-S diagram. | Remember | CO 1 | AAEB02.03 |
| 14 | Sketch the constant volume gas thermometer and explain its working in detail? | Remember | CO 1 | AAEB02.03 |
| 15 | List the scales of temperature and explain in detail? | Understand | CO 1 | AAEB02.03 |
| 16 | Indicate the polytropic process on T-S diagram and explain. | Remember | CO 1 | AAEB02.03 |
| 17 | Compare the first law of thermodynamics with its corollaries? | Remember | CO 1 | AAEB02.03 |
| 18 | Explain how the first law of thermodynamics applied to a process? | Understand | CO 1 | AAEB02.03 |
| 19 | Indicate the Isentropic process on P-V diagram and explain about it in detail. | Understand | CO 1 | AAEB02.03 |
| 20 | Explain the Steady flow energy equation? Explain with help of a neat diagram. | Understand | CO 1 | AAEB02.03 |
| **Part - C (Problem Solving and Critical Thinking Questions)** | | | | |
| 1 | The pressure of gas in a pipe line is measured with a mercury manometer having one limb open to the atmosphere(as shown in fig.). If the difference in the height of mercury in the two limbs is 562 mm, calculate the gas pressure. The barometer reads 761 mm Hg, the acceleration due to gravity is 9.79 $m/s^2$, and the density of mercury is 13,640 $kg/m^3$.   | Understand | CO 1 | AAEB02.01 |
| 2 | Two mercury-in-glass thermometers arc made of identical materials and are- accurately calibrated at 0°C and I00°C. One has a | Remember | CO 1 | AAEB02.01 |

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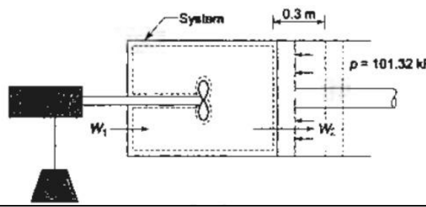
| | tube of constant diameter, while the other has a tube of conical bore, ten per cent greater in diameter at I00°C than at 0°C. Both thermometers have the length between 0 and 100 subdivided uniformly. What will be the straight bore thermometer read in a place where the conical bore thermometer reads 50°C? | | | |
| 3 | A piston and cylinder machine containing a fluid system has a Stirring device in the cylinder (Fig. 2). The piston is frictionless, and it is held down against the fluid due to the atmospheric pressure of 101 .325 kPa. The stirring device is turned 10,000 revolutions with an average torque against the fluid of l.275 mN. Meanwhile the piston of 0.6 m diameter moves out 0.8 m. Find the net work transfer for the system.   | Remember | CO 1 | AAEB02.02 |
| 4 | It is required to melt 5 tonnes/h of iron from a charge at 15°C to molten metal at l650°C. The melting point is 1535°C, and the latent heat is 270 kJ/kg. The specific heat in solid state is 0.502 and in liquid state (29.93/atomic weight) kJ/kg K. If an electric furnace has 70% efficiency, find the kW rating needed. If the density in molten state is 6900 kg/m3 and the bath volume is three times the hourly melting rate, find the dimensions of the cylindrical furnace if the length to diameter ratio is 2. The atomic weight of iron is 56. | Understand | CO 1 | AAEB02.02 |
| 5 | If it is desired to melt aluminum with solid state specific heat 0. 9 kJ/kgK, latent heat 390 kJ/kg, atomic weight 27, density in molten state 2400 kg/$m^3$ and final temperature 700°C, find out how much metal can be melted per hour with the above kW rating. Other data are as in the above example. Also, find the mass of aluminum that the above furnace will bold. The melting point of aluminum is 660°C. | Remember | CO 1 | AAEB02.03 |
| 6 | A temperature scale of certain thermometer is given by the relation<br>$t = a \ln p + b$<br>where a and b are constants and p is the thermometric property of the fluid in the thermometer. If at the ice point and steam point the thermometric properties are found to be 1.5 and 7.5 respectively what will be the temperature corresponding to the thermometric property of 3.5 on Celsius scale. | Remember | CO 1 | AAEB02.03 |
| 7 | The properties of a closed system change following the relation between pressure and volume as pV = 3.0 where p is in bar V is in m3. Calculate the work done when the pressure increases from 1.5 bar to 7.5 bar. | Understand | CO 1 | AAEB02.03 |
| 8 | To a closed system 150 kJ of work is supplied. If the initial volume is 0.6 m3 and pressure of the system changes as p = 8 – 4V, where p is in bar and V is in m3, determine the final volume and pressure of the system. | Remember | CO 1 | AAEB02.03 |
| 9 | A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law $pV^2$ = constant untilthe volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position ; heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m3. | Remember | CO 1 | AAEB02.03 |

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| 10 | A fluid at a pressure of 3 bar, and with specific volume of 0.18 m3/kg, contained in a cylinder behind a piston expands reversibly to a pressure of 0.6 bar according to a law, $p = C/v^2$ where C is a constant. Calculate the work done by the fluid on the piston. | Understand | CO 1 | AAEB02.03 |
| **MODULE-II** | | | | |
| **SECOND LAW OF THERMODYNAMICS** | | | | |
| **Part – A (Short Answer Questions)** | | | | |
| 1 | State the limitations of first law of thermodynamics. | Understand | CO 2 | AAEB02.04 |
| 2 | Define second law of thermodynamics. | Remember | CO 2 | AAEB02.04 |
| 3 | State PMM 2. | Remember | CO 2 | AAEB02.04 |
| 4 | State the Carnot Cycle. | Understand | CO 2 | AAEB02.04 |
| 5 | State the Clausius inequality. | Remember | CO 2 | AAEB02.04 |
| 6 | Define the absolute temperature scale. | Remember | CO 2 | AAEB02.04 |
| 7 | State the property of entropy. | Understand | CO 2 | AAEB02.04 |
| 8 | Define an inversion curve. | Remember | CO 2 | AAEB02.04 |
| 9 | Solve one T -dS equation by using Maxwell's relations. | Remember | CO 2 | AAEB02.05 |
| 10 | State the Third law of Thermodynamics. | Understand | CO 2 | AAEB02.05 |
| 11 | Define internal energy of a system. | Remember | CO 2 | AAEB02.05 |
| 12 | Define the change in internal energy of a system. | Remember | CO 2 | AAEB02.05 |
| 13 | Explain the available energy in a system. | Understand | CO 2 | AAEB02.04 |
| 14 | State the unavailable energy in a system. | Remember | CO 2 | AAEB02.05 |
| 15 | Explain the principle of entropy increase. | Knowledge | CO 2 | AAEB02.05 |
| 16 | Explain the energy of a system. | Understand | CO 2 | AAEB02.05 |
| 17 | Explain the Clausius statement. | Understand | CO 2 | AAEB02.05 |
| 18 | State the Kelvin-Plank statement. | Remember | CO 2 | AAEB02.05 |
| 19 | Sketch the PV and TS diagrams of Carnot cycle. | Remember | CO 2 | AAEB02.05 |
| 20 | Classify the processes which constitute the cycle. | Understand | CO 2 | AAEB02.05 |
| **Part - B (Long Answer Questions)** | | | | |
| 1 | Explain the limitations of First law of thermodynamics in detail? | Understand | CO 2 | AAEB02.06 |
| 2 | Explain about thermal reservoir with a neat sketch? | Remember | CO 2 | AAEB02.07 |
| 3 | Explain the heat engine with a neat sketch? | Remember | CO 2 | AAEB02.06 |
| 4 | Explain the heat pump with a neat sketch? | Understand | CO 2 | AAEB02.07 |
| 5 | List the performance parameters of a system and explain in detail. | Remember | CO 2 | AAEB02.06 |
| 6 | Compare the first law and second law of thermodynamics with suitable examples. | Remember | CO 2 | AAEB02.07 |
| 7 | Explain the second law of thermodynamics with suitable sketches? | Understand | CO 2 | AAEB02.06 |
| 8 | Write the Kelvin-Plank statement and explain with an example? | Understand | CO 2 | AAEB02.07 |
| 9 | Write the Clausius statement and explain with an example? | Understand | CO 2 | AAEB02.06 |
| 10 | Write the Kelvin-Planck and Clausius statements and explain with sketches? | Understand | CO 2 | AAEB02.07 |
| 11 | State PMM1 and PMM2, are they different? How? | Remember | CO 2 | AAEB02.06 |
| 12 | Compare the relation with process and cycle? Explain. | Remember | CO 2 | AAEB02.07 |
| 13 | State the Carnot's principle? What is the importance of the principle? | Remember | CO 2 | AAEB02.06 |
| 14 | State the Clausius inequality? Explain. | Understand | CO 2 | AAEB02.07 |
| 15 | Explain the influence of entropy on various parameters? | Remember | CO 2 | AAEB02.04 |
| 16 | Define Gibb's and Helmholtz's functions? | Remember | CO 2 | AAEB02.05 |
| 17 | State the irreversibility and explain. | Understand | CO 2 | AAEB02.04 |
| 18 | Explain the Availability in a thermodynamic system with example. | Remember | CO 2 | AAEB02.07 |
| 19 | Discuss the importance of Maxwell relations? | Understand | CO 2 | AAEB02.05 |
| 20 | State the Third law of thermodynamics? Explain the importance. | Remember | CO 2 | AAEB02.05 |
| **Part - C (Problem Solving and Critical Thinking Questions)** | | | | |
| 1 | cyclic heat engine operates between a sonrce temperature of | Understand | CO 2 | AAEB02.06 |

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| | 800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine? | | | |
| 2 | A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and - 20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. | Understand | CO 2 | AAEB02.07 |
| 3 | A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine the thermal efficiency and the rate of heat rejection. | Remember | CO 2 | AAEB02.06 |
| 4 | A domestic food freezer maintains a temperature of -15$^0$C, the ambient air temperature is 30$^0$C, if heat leaks into the freezer at the continuous rate of 1.75kJ/sec. State the least power necessary to pump this heat out continuous? | Remember | CO 2 | AAEB02.07 |
| 5 | Find the co-efficient of performance and heat transfer rate in the condenser of a refrigerator in kJ/h which has a refrigeration capacity of 12000 kJ/h when power input is 0.75 kW. | Understand | CO 2 | AAEB02.04 |
| 6 | A cyclic heat engine operates between a source temperature of 1000°C and a sink temperature of 40°C. Find the least rate of heat rejection per kW net output of the engine? | Remember | CO 2 | AAEB02.04 |
| 7 | A fish freezing plant requires 40 tons of refrigeration. The freezing temperature is – 35°C while the ambient temperature is 30°C. If the performance of the plant is 20% of the theoretical reversed Carnot cycle working within the same temperature limits, calculate the power required. | Remember | CO 2 | AAEB02.04 |
| 8 | A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and – 25°C. The heat transfer to the engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 400 kJ. Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C. | Understand | CO 2 | AAEB02.07 |
| 9 | An ice plant working on a reversed Carnot cycle heat pump produces 15 tonnes of ice per day. The ice is formed from water at 0°C and the formed ice is maintained at 0°C. The heat is rejected to the atmosphere at 25°C. The heat pump used to run the ice plant is coupled to a Carnot engine which absorbs heat from a source which is maintained at 220°C by burning liquid fuel of 44500 kJ/kg calorific value and rejects the heat to the atmosphere. Determine power developed by the engine and fuel consumed per hour. Take enthalpy of fusion of ice = 334.5 kJ/kg. | Remember | CO 2 | AAEB02.04 |
| 10 | Two Carnot engines work in series between the source and sink temperatures of 550 K and 350 K. If both engines develop equal power determine the intermediate temperature. | Remember | CO 2 | AAEB02.04 |
| **MODULE -III** | | | | |
| **PURE SUBSTANCES AND MIXTURES OF PERFECT GASES** | | | | |
| **Part - A (Short Answer Questions)** | | | | |
| 1 | What is a pure substance? | Remember | CO 3 | AAEB02.08 |
| 2 | What are saturation states? | Remember | CO 3 | AAEB02.08 |
| 3 | What do you understand by triple point'? | Remember | CO 3 | AAEB02.08 |
| 4 | What is the pressure and temperature of water at its triple point. | Remember | CO 3 | AAEB02.08 |
| 5 | What is normal boiling point? | Remember | CO 3 | AAEB02.09 |

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| 6 | Why do the isobars on Mollier diagram diverge from one another? | Remember | CO 3 | AAEB02.09 |
| 7 | Draw the phase diagram on p-v diagrams with water as pure substance. | Remember | CO 3 | AAEB02.08 |
| 8 | Explain the concept of p-v-T surface? Represent on p-T coordinates? | Understand | CO 3 | AAEB02.09 |
| 9 | Compare isobar on Mollier diagram diverse from one another? | Understand | CO 3 | AAEB02.09 |
| 10 | Explain the phase transformation process with a diagram? | Understand | CO 3 | AAEB02.09 |
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| 11 | Define saturated air. | Remember | CO 3 | AAEB02.10 |
| 12 | Define dry bulb temperature | Remember | CO 3 | AAEB02.10 |
| 13 | Define Dew point temperature | Remember | CO 3 | AAEB02.10 |
| 14 | Define relative humidity | Remember | CO 3 | AAEB02.10 |
| 15 | Define specific humidity | Remember | CO 3 | AAEB02.10 |
| 16 | Describe a psychrometer | Remember | CO 3 | AAEB02.10 |
| 17 | Define psychrometry | Remember | CO 3 | AAEB02.11 |
| 18 | Draw the schematic of a psychrometric chart. | Remember | CO 3 | AAEB02.11 |
| 19 | Write down three other types of psychrometric instruments. | Remember | CO 3 | AAEB02.11 |
| 20 | What is mixture of perfect gases? | Remember | CO 3 | AAEB02.10 |
| **Part – B (Long Answer Questions)** | | | | |
| 1 | What is the critical state? Explain the tenns critical pressure, critical temperature and critical volume of water? | Remember | CO 3 | AAEB02.08 |
| 2 | Draw the phase equilibrium diagram on p-v coordinates for a substance which shrinks in volume on melting and then for a substance which expands in volume on melting. Indicate there on the relevant constant property lines. | Remember | CO 3 | AAEB02.08 |
| 3 | Draw the phase equilibrium diagram for a pure substance on p-T coordinates. Why does the fusion line for water have negative slope? | Remember | CO 3 | AAEB02.08 |
| 4 | Draw the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property lines. | Remember | CO 3 | AAEB02.08 |
| 5 | Draw the phase equilibrium diagram for a pure substance on h-s plot with relevant constant property lines. | Remember | CO 3 | AAEB02.08 |
| 6 | Why do isotherms on Mollier diagram become horizontal in the superheated region at low pressures? | Remember | CO 3 | AAEB02.09 |
| 7 | Enumerate the Perfect Gas Laws and analyze from thermodynamics point of view? | Understand | CO 3 | AAEB02.09 |
| 8 | Explain, how the heat and work transfer observed in perfect gas? | Understand | CO 3 | AAEB02.09 |
| 9 | Explain the equation of State with variations? | Understand | CO 3 | AAEB02.09 |
| 10 | Write the properties of water at Triple point and what are state properties? | Remember | CO 3 | AAEB02.09 |
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| 11 | Explain briefly with a neat sketch a sling psychrometer. | Understand | CO 3 | AAEB02.10 |
| 12 | Write in detail about by pass factor. | Understand | CO 3 | AAEB02.10 |
| 13 | Describe briefly about a) Sensible heating. b) Cooling and dehumidification. | Understand | CO 3 | AAEB02.10 |
| 14 | Explain in detail about terms ‘heating and dehumidification’ and ‘heating and dehumidification. | Understand | CO 3 | AAEB02.10 |
| 15 | A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapor form, determine the pressure in the tank and the volume of the tank. | Understand | CO 3 | AAEB02.10 |
| 16 | Moist air at 1 atm. pressure has a dry bulb temperature of 32o C and | Understand | CO 3 | AAEB02.11 |

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| | a wet bulb temperature of 26o C. Calculate a) the partial pressure of water vapour, b) humidity ratio, c) relative humidity, d) dew point temperature, e) density of dry air in the mixture, f) density of water vapour in the mixture and g) enthalpy of moist air using perfect gas law model and psychrometric equations. | | | |
| 17 | Explain about different lines and curves that are present in a psychrometric chart. | Understand | CO 3 | AAEB02.11 |
| 18 | Water at 30°C flows into a cooling tower at the rate of 1.15 kg per kg of air. Air enters the tower at a dbt of20°C and a relative humidity of 60% and leaves it at a dbt of 28°C and 90% relative humidity. Make-up water is supplied at 20°C. Determine: (i) the temperature of water leaving the tower, (ii) the fraction of water evaporated, and (iii) the approach and range of the cooling tower. | Understand | CO 3 | AAEB02.10 |
| 19 | Water at 30°C flows into a cooling tower at the rate of 1.15 kg per kg of air. Air enters the tower at a dbt of20°C and a relative humidity of 60% and leaves it at a dbt of 28°C and 90% relative humidity. Make-up water is supplied at 20°C. Determine: (i) the temperature of water leaving the tower, (ii) the fraction of water evaporated, and (iii) the approach and range of the cooling tower. | Understand | CO 3 | AAEB02.10 |
| 20 | Water from a cooling system is itself to be cooled in a cooling tower at a rate of 2.78 kg/s. The water enters the tower at 65°C and leaves a collecting tank at the base at 38°C. Air flows through 1he tower, entering the base at 15°C, 0.1 MPa, 55% RH, and leaving the top at 35°C, 0.1 MPa, saturated. Make up water enters the collecting tank at 14°C. Determine the air flow rate into the tower in m3/s and the make-,up water flow rate in kg/s. | Understand | CO 3 | AAEB02.11 |
| | **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | A vessel having a volume of 0.6 m3 contains 3.0 kg of liquid water and water vapour mixture in equilibrium at a pressure of 0.5 MPa. Calculate mass and volume of liquid and also the mass and volume of vapour. | Understand | CO 3 | AAEB02.08 |
| 2 | 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. Find the pressure and mass, the specific volume, the specific enthalpy, the specific entropy, and the specific internal energy. | Understand | CO 3 | AAEB02.08 |
| 3 | Determine the amount of heat, which should be supplied to 2 kg of water at 25°C to convert it into steam at 5 bar and 0.9 dry. | Understand | CO 3 | AAEB02.08 |
| 4 | What amount of heat would be required to produce 4.4 kg of steam at a pressure of 6 bar and temperature of 250°C from water at 30°C? Take specific heat for superheated steam as 2.2 kJ/kg K. | Understand | CO 3 | AAEB02.08 |
| 5 | 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 super heater via boiler stop valve where its temperature is raised to 380°C. If the temperature of feed water is 30°C, determine the total heat supplied to feed water per hour to produce wet steam and the total heat absorbed per hour in the super heater. | Understand | CO 3 | AAEB02.11 |
| 6 | A pressure cooker contains 1.5 kg of saturated steam at 5 bar. Find the quantity of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature of the steam at the new state. | Understand | CO 3 | AAEB02.11 |

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| 7 | A spherical vessel of 0.9 m3 capacity contains steam at 8 bar and 0.9 dryness fraction. Steam is blown off until the pressure drops to 4 bar. The valve is then closed and the steam is allowed to cool until the pressure falls to 3 bar. Assuming that the enthalpy of steam in the vessel remains constant during blowing off periods, determine :<br>(i) The mass of steam blown off ;<br>(ii) The dryness fraction of steam in the vessel after cooling ;<br>(iii) The heat lost by steam per kg during cooling. | Understand | CO 3 | AAEB02.11 |
| 8 | 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. | Understand | CO 3 | AAEB02.11 |
| 9 | Two boilers one with super heater and other without super heater are delivering equal quantities of steam into a common main. The pressure in the boilers and main is 20 bar. The temperature of steam from a boiler with a super heater is 350°C and temperature of the steam in the main is 250°C. Determine the quality of steam supplied by the other boiler. Take $C_{ps}$ = 2.25 kJ/kg. | Understand | CO 3 | AAEB02.11 |
| 10 | A piston-cylinder contains 3 kg of wet steam at 1.4 bar. The initial volume is 2.25 m3. The steam is heated until its temperature reaches 400°C . The piston is free to move up or down unless it reaches the stops at the top. When the piston is up against the stops the cylinder volume is 4.65 m3. Determine the amount of work and heat transfer to or from steam. | Understand | CO 3 | AAEB02.11 |
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| 11 | 0.004 kg of water vapour per kg of atmospheric air is removed and temperature of air after removing the water vapour becomes 20°C. Determine relative humidity, dew point temperature. Assume that condition of atmospheric air is 30°C and 55% R.H. and pressure is 1.0132 bar. | Understand | CO 3 | AAEB02.10 |
| 12 | The atmospheric conditions are; 20°C and specific humidity of 0.0095 kg/kg of dry air. Calculate the following partial pressure of vapour, relative humidity and dew point temperature. | Understand | CO 3 | AAEB02.10 |
| 13 | The air supplied to a room of a building in winter is to be at 17°C and have a relative humidity of 60%. If the barometric pressure is 1.01325 bar, find the specific humidity the dew point under these conditions. | Understand | CO 3 | AAEB02.11 |
| 14 | One kg of air at 35°C DBT and 60% R.H. is mixed with 2 kg of air at 20°C DBT and 13°C dew point temperature. Calculate the specific humidity of the mixture. | Understand | CO 3 | AAEB02.11 |
| 15 | An air-water vapour 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 1 kg/s. The air-vapour mixture leaves the air-conditioning unit at 1.0 bar, 18°C, 85% relative humidity. The moisture condensed leaves at 18°C. Determine the heat transfer rate for the process. | Understand | CO 3 | AAEB02.10 |
| 16 | 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 :<br>(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. | Understand | CO 3 | AAEB02.10 |
| 17 | A cooling tower used in power plant consists of 10 big fans, m_ | Understand | CO 3 | AAEB02.11 |

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| | water = 1000 kg/min. It is cooled from 35ºC to 30ºC. Atmospheric conditions are 35ºC DBT, 25ºC WBT. Air leaves the tower at 30ºC, 90% RH. Find out the quantity of air handled per fan hour and the quantity of make-up water required per hour. | | | |
| 18 | The following data pertain to an air-conditioning system : Unconditioned space DBT = 30ºC Unconditioned space WBT = 22ºC Cold air duct supply surface temperature = 14ºC. Determine dew point temperature and also determine whether or not condensation will form on the duct. | Understand | CO 3 | AAEB02.11 |
| 19 | It is required to design an air-conditioning system for an industrial process for the following hot and wet summer conditions :<br>Outdoor conditions - 32ºC DBT and 65% R.H.<br>Required air inlet conditions - 25ºC DBT and 60% R.H.<br>Amount of free air circulated - 250 $m^3$/min.<br>Coil dew temperature - 13ºC.<br>The required condition is achieved by first cooling and dehumidifying and then by heating. Calculate the following :<br>(i) The cooling capacity of the cooling coil and its by-pass factor.<br>(ii) Heating capacity of the heating coil in kW and surface temperature of the heating coil if the by-pass factor is 0.3.<br>(iii) The mass of water vapour removed per hour. | Understand | CO 3 | AAEB02.11 |
| 20 | Air at 20°C, 40% RH is mixed adiabatically with air at 40°C, 40% RH in the ratio of I kg of the former with 2 kg of the latter (on dry basis) .Find the final condition of air. | Understand | CO 3 | AAEB02.11 |
| **MODULE -IV** | | | | |
| **POWER CYCLES** | | | | |
| **Part – A (Short Answer Questions)** | | | | |
| 1 | Classify the assumptions to be made for the analysis of all air standard cycles? | Understand | CO 4 | AAEB02.12 |
| 2 | State the Processes in Otto cycle and represent on P-V and T-S | Understand | CO 4 | AAEB02.12 |
| 3 | State the Processes in Constant pressure cycle and represent on P-V | Understand | CO 4 | AAEB02.12 |
| 4 | What are the variable factors used for comparison of cycles? | Understand | CO 4 | AAEB02.12 |
| 5 | Draw the modified Otto cycle? How it differs from Otto cycle? | Understand | CO 4 | AAEB02.13 |
| 6 | Derive the air standard efficiency of Diesel cycle? | Understand | CO 4 | AAEB02.14 |
| 7 | Define mean effective pressure? | Understand | CO 4 | AAEB02.14 |
| 8 | List functional parts of simple vapor compression system represent the processes on T-S diagram. | Remember | CO 4 | AAEB02.14 |
| 9 | Represent Dual cycle on P-V and T-S diagram | Remember | CO 4 | AAEB02.14 |
| 10 | Sketch P-V and T-S diagrams of Bell-Coleman cycle while representing the process and hence deduce its COP. | Remember | CO 4 | AAEB02.14 |
| 11 | Discuss limited pressure cycle, represent the processes of it on P-V | Understand | CO 4 | AAEB02.14 |
| 12 | Compare Otto cycle with Diesel cycle? | Understand | CO 4 | AAEB02.14 |
| 13 | Define the unit of refrigeration? | Understand | CO 4 | AAEB02.13 |
| 14 | Define COP of refrigeration? | Understand | CO 4 | AAEB02.13 |
| 15 | Represent Diesel cycle on P-V and T-S diagram | Remember | CO 4 | AAEB02.14 |
| 16 | Write the processes involved in Brayton cycle. | Remember | CO 4 | AAEB02.13 |
| 17 | Evaluate the performance of refrigeration cycle? | Understand | CO 4 | AAEB02.13 |
| 18 | Represent Otto cycle on P-V and T-S diagram | Remember | CO 4 | AAEB02.13 |
| 19 | Draw the PV and TS diagrams of dual combustion cycle? | Understand | CO 4 | AAEB02.14 |
| 20 | Represent Brayton cycle on P-V and T-S diagram | Remember | CO 4 | AAEB02.14 |
| **Part – B (Long Answer Questions)** | | | | |
| 1 | Define compression ratio. What is the range for (a) SI engines (b) The CI engine? What factors limit the compression ratio in each | Understand | CO 4 | AAEB02.14 |

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| | type of engine? | | | |
| 2 | What is an air standard cycle? What are the limitations of air standard cycle? State the assumptions to be taken for its analysis | Understand | CO 4 | AAEB02.14 |
| 3 | Obtain an expression for the air standard efficiency on a volume basis of an engine working on the Otto cycle. And represent the processes on p-V and T-S diagrams. | Understand | CO 4 | AAEB02.14 |
| 4 | State the characteristic of air cycles? And what is the use of air standard cycle analysis | Understand | CO 4 | AAEB02.14 |
| 5 | Define air standard efficiency of an Otto cycle and show that the efficiency of Otto cycle is lower than that of Carnot cycle. | Remember | CO 4 | AAEB02.14 |
| 6 | Derive an expression for mean effective pressure of the Otto cycle? | Remember | CO 4 | AAEB02.14 |
| 7 | Derive an expression for air standard efficiency of diesel cycle | Remember | CO 4 | AAEB02.14 |
| 8 | What is the difference between Otto and Diesel cycle? Show that the efficiency of Diesel cycle is always lower than the efficiency of the Otto cycle for the same compression ratio. | Understand | CO 4 | AAEB02.14 |
| 9 | Show by graphs how the efficiency of Diesel cycle varies with compression ratio and cutoff ratio. | Understand | CO 4 | AAEB02.14 |
| 10 | Explain the dual combustion cycle? Why the cycle is also called limited pressure cycle? Represent on p-V and T-S diagrams. | Understand | CO 4 | AAEB02.14 |
| 11 | What are the processes involved in Otto cycle. Explain their standard efficiency of Otto cycle. | Understand | CO 4 | AAEB02.14 |
| 12 | Compare the Otto and Diesel cycles for same constant maximum pressure and same heat input. | Understand | CO 4 | AAEB02.12 |
| 13 | Compare the thermal efficiency of Otto and dual and diesel cycles on the basis of same compression ratio and same heat input? | Understand | CO 4 | AAEB02.12 |
| 14 | Derive an expression for air standard efficiency of dual cycle | Understand | CO 4 | AAEB02.14 |
| 15 | In an Otto cycle, the pressure at the beginning of the compression is 1 bar and pressure at the end of compression is 15 bar. Calculate the pressure ratio and the air standard efficiency of engine. | Remember | CO 4 | AAEB02.14 |
| 16 | Determine the air standard efficiency of the diesel engine having a cylinder with a bore of 250 mm and a stroke of 375mm and a clearance volume of 1500 cc. with fuel cutoff occurring at 5% of the stroke. | Remember | CO 4 | AAEB02.14 |
| 17 | Describe the components of vapour compression system with the help of P-V and T-S diagram. | Remember | CO 4 | AAEB02.13 |
| 18 | Explain the following (i)Wet Compression (ii)Dry compression (iii)sub cooling (iv)superheating | Understand | CO 4 | AAEB02.13 |
| 19 | Derive cop of Bell-Coleman cycle with the help of processes representing on p-V and T-S diagram? | Understand | CO 4 | AAEB02.13 |
| 20 | Derive the expression for air standard efficiency of Brayton cycle | Understand | CO 4 | AAEB02.14 |
| **Part – C (Problem Solving and Critical Thinking)** | | | | |
| 1 | A R-12 refrigerator works between the temperature limits of – 10°C and+ 30°C. The compressor employed is of 20 cm × 15 cm, twin cylinder, single-acting compressor having a volumetric efficiency of 85%. The compressor runs at 500 r.p.m. The refrigerant is sub-cooled and it enters at 22°C in the expansion valve. The vapour is superheated and enters the compressor at – 2°C. Work out the following : | Understand | CO 4 | AAEB02.13 |

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| | (i) Show the process on T-s and p-h diagrams ;<br>(ii) The amount of refrigerant circulated perminute ;<br>(iii) The tonnes of refrigeration ;<br>(iv) The C.O.P. of the system. | | | |
| 2 | The evaporator and condenser temperatures of 20 tonnes capacity freezer are – 28°C and 23°C respectively. The refrigerant – 22 is sub cooled by 3°C before it enters the expansion valve and is superheated to 8°C before leaving the evaporator. The compression is isentropic. A six-cylinder single-acting compressor with stroke equal to bore running at 250 r.p.m.is used. Determine : (i) Refrigerating effect/kg. (ii) Mass of refrigerant to be circulated per minute. (iii) Theoretical piston displacement per minute. (iv) Theoretical power. | Remember | CO 4 | AAEB02.14 |
| 3 | An engine with 200mm cylinder diameter and 300mm stroke working on theoretical diesel cycle. The initial pressure and temperature of air used are 1bar and 270C. The cut of is 8% of the stroke. Determine air standard efficiency, mean effective pressure and power of the engine if the working cycles per minute are 300? Assume the compression ratio is 15 and the working fluid is air. | Remember | CO 4 | AAEB02.14 |
| 4 | a) Determine the Compression ratio, if efficiency of an Otto cycle is 60% and ɣ = 1.5? b) An inventor claims that a new heat cycle will develop 0.4kw for a heat addition of 32.5kJ/min. The temperature of heat source is 1990K and that of sink is 850K. Is his claim possible? | Understand | CO 4 | AAEB02.13 |
| 5 | 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°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 cp of refrigerant vapour may be taken to be 0.6155 kJ/kg°C. | Remember | CO 4 | AAEB02.14 |
| 6 | The stroke and cylinder diameter of Compression Ignition engine are 250mm and 150mm respectively. If the clearance volume is 0.0004m3 and fuel injection takes place at constant pressure for 5% of the stroke. Determine the efficiency of the engine. Assume the engine working on Diesel cycle? | Remember | CO 4 | AAEB02.14 |
| 7 | An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is 0.00263m3. The initial pressure and temperature are 1bar and $50^0$C. The maximum pressure is limited to 25 bar. Find the air standard efficiency and the mean effective pressure of the cycle? Assume ideal conditions? | Remember | CO 4 | AAEB02.14 |
| 8 | A cold storage is to be maintained at -50C while the surrounding are at 350C.the heat leakage from the surrounding into cold storage is estimated to be 29kW.the actual C.O.P. of the refrigeration plant used is one third that of an ideal working between the same temperatures. Find the power required to drive the plant. | Remember | CO 4 | AAEB02.12 |
| 9 | A Bell-Coleman refrigerator operates between pressure limits of 1bar and 8bar. Air is drawn from the cold chamber at 90C, compressed and then it is cooled to 290C before entering the expansion cylinder. Expansion and compression follow the law pV1.35=C. Calculate theoretical C.O.P of the system. Take ɣ of air is 1.4. | Remember | CO 4 | AAEB02.12 |
| 10 | The capacity of the refrigerator (working on reversed carnot cycle)is 280 tonnes when operating between -100C and 250C.determine the quantity of ice produced within 24 hours when water is supplied at | Remember | CO 4 | AAEB02.14 |

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| | 200C and the minimum power (in kW) required. | | | |
| **MODULE -V** | | | | |
| **ELEMENTS OF HEAT TRANSFER AND GAS COMPRESSORS** | | | | |
| **Part - A (Short Answer Questions)** | | | | |
| 1 | What are the three basic modes in which heat is transferred? | Remember | CO 5 | AAEB02.15 |
| 2 | Why are good electrical conductors also good thermal conductors? | Remember | CO 5 | AAEB02.15 |
| 3 | What is fourier's law of heat conduction? | Remember | CO 5 | AAEB02.15 |
| 4 | How does the slope of the temperature profile in a wall depend on its thermal conductivity? | Remember | CO 5 | AAEB02.15 |
| 5 | How do fins effect the heat transfer rate? | Remember | CO 5 | AAEB02.15 |
| 6 | How is fin efficiency defined? | Remember | CO 5 | AAEB02.15 |
| 7 | What is meant by transient heat conduction? | Remember | CO 5 | AAEB02.15 |
| 8 | What is lumped – capacity analysis? | Remember | CO 5 | AAEB02.15 |
| 9 | What is a heat exchanger? | Remember | CO 5 | AAEB02.15 |
| 10 | Define emissivity. | Remember | CO 5 | AAEB02.15 |
| 11 | What is reflectivity? | Remember | CO 5 | AAEB02.15 |
| 12 | Define transmissivity. | Remember | CO 5 | AAEB02.15 |
| 13 | What is black body? | Remember | CO 5 | AAEB02.15 |
| 14 | What is reciprocity theorem? | Remember | CO 5 | AAEB02.15 |
| 15 | What is gray body? | Remember | CO 5 | AAEB02.15 |
| 16 | What is meant by monochromatic emissive power? | Remember | CO 5 | AAEB02.15 |
| 17 | What is meant by total emissive power? | Remember | CO 5 | AAEB02.15 |
| 18 | What is view factor? | Remember | CO 5 | AAEB02.15 |
| 19 | Define effectiveness. | Remember | CO 5 | AAEB02.15 |
| 20 | Define heat capacity ratio. | Remember | CO 5 | AAEB02.15 |
| 21 | Classify compressors. | Understand | CO 5 | AAEB02.16 |
| 22 | Define isothermal efficiency. | Remember | CO 5 | AAEB02.16 |
| 23 | What do you understand by multi stage compression? | Remember | CO 5 | AAEB02.16 |
| 24 | What do you understand by surging and choking phenomenon? | Remember | CO 5 | AAEB02.16 |
| 25 | What is free air delivery? | Remember | CO 5 | AAEB02.16 |
| 26 | What is volumetric efficiency? | Remember | CO 5 | AAEB02.16 |
| 27 | Write a short notes on air flow rate measurement in reciprocating compresors. | Understand | CO 5 | AAEB02.16 |
| **Part - B (Long Answer Questions)** | | | | |
| 1 | Derive an expression for the rate of heat transfer for a surface area normal to heat flow. | Understand | CO 5 | AAEB02.15 |
| 2 | Show that, for estimating radial heat conduction through a cylindrical wall, the log- mean area of the inner and outer surfaces to be considered. | Understand | CO 5 | AAEB02.15 |
| 3 | Show that, for estimating radial heat conduction through a spherical wall, the geometric mean area of the inner and outer surfaces to be considered | Understand | CO 5 | AAEB02.15 |
| 4 | What do you understand by natural convention and forced convention? Give relevant examples. | Remember | CO 5 | AAEB02.15 |
| 5 | What is heat transfer coefficient? How is it defined? What is its dimension? | Understand | CO 5 | AAEB02.15 |
| 6 | What are the three resistances offered to heat transfer from one fluid to another through a clean wall? | Remember | CO 5 | AAEB02.15 |
| 7 | Explain about different types of heat exchangers in detail. | Understand | CO 5 | AAEB02.15 |

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| 8 | Why are counter flow heat exchangers superior to parallel flow heat exchangers? | Remember | CO 5 | AAEB02.15 |
| 9 | Find the expression for effectiveness of a balanced heat exchanger with equal heat capacities. | Understand | CO 5 | AAEB02.15 |
| 10 | What is view factor? Why is it significant in radiant heat exchange between two bodies? | Remember | CO 5 | AAEB02.16 |
| 11 | Discuss the applications of compressed air to high light the significance of compressors. | Understand | CO 5 | AAEB02.16 |
| 12 | Describe working of single stage reciprocating compressor. | Remember | CO 5 | AAEB02.16 |
| 13 | Discuss the indicator diagram for reciprocating compressor. Also describe the factors responsible for deviation of hypothetical indicator diagram to actual diagram. | Understand | CO 5 | AAEB02.16 |
| 14 | Obtain volumetric efficiency of single stage reciprocating compressor with clearance volume and without clearance volume. | Understand | CO 5 | AAEB02.16 |
| 15 | Discuss the effects of clearance upon the performance of reciprocating compressor. | Understand | CO 5 | AAEB02.16 |
| 16 | Define is isothermal efficiency. Write in detail about its significance. | Remember | CO 5 | AAEB02.16 |
| 17 | What do you understand by multi stage compression? | Remember | CO 5 | AAEB02.15 |
| 18 | Write down the merits of multi stage compression over single stage compression. | Remember | CO 5 | AAEB02.16 |
| 19 | Write down equation for volumetric efficiency with respect to free air delivery with all the terms of expression explained in detail. | Remember | CO 5 | AAEB02.16 |
| 20 | Discuss the significance of intercooling upon the performance of multi stage compression. | Understand | CO 5 | AAEB02.16 |
| 21 | Discuss the working of positive displacement rotary compressors. | Understand | CO 5 | AAEB02.16 |
| 22 | Describe the working of centrifugal compressors. | Remember | CO 5 | AAEB02.16 |
| 23 | Explain stalling and its effect on the compressor performance. | Understand | CO 5 | AAEB02.16 |
| 24 | Compare the axial flow compressor and centrifugal flow compressor. | Understand | CO 5 | AAEB02.16 |
| | **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | Three 10 mm dia. Rods A, B and C protrude from a steam path at I00°C to a length of 0.25 m into the atmosphere at 20°C. The temperatures of the other ends are found to be 26.76°C for A, 32.00°C for B and 36.93°C for C. Neglecting the effects of radiation and assuming the surface film coefficient of 23 W/m$^2$K, evaluate their thermal conductivities. | Understand | CO 5 | AAEB02.15 |
| 2 | An oil cooler for a lubrication system has to cool I 000 kg/h of oil (c,. = 2.09 kJ/kg K) from 80°C to 40°C by using a cooling water flow of 1000 kg/h available at 30°C. Give your choice for a parallel flow or counter flow heat exchanger, with reasons. Estimate the surface area of the heat exchanger. if the overall heat transfer coefficient is 24 W/rn$^2$ K (cl' of water= 4.18 kJ/kg K). | Understand | CO 5 | AAEB02.15 |
| 3 | An oil fraction at 121 °C is to be cooled at the rate of 20.15 kg/s in a simple counter flow heat exchanger using 5.04 kgs of water initially at 10°C. The exchanger contains 200 tubes each 4.87 m long and 1.97 cm o.d., with $U_0$ = 0.34 kW/m K. If the specific heat of oil is 2.094 kJ/kgK, calculate the exit temperature of the oil and the rate of heat transfer. | Understand | CO 5 | AAEB02.15 |
| 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 l.5 cm of wood on the inside. The outside and inside air temperatures are 22°C and - 2°C respectively. If the inside and outside heat transfer coefficients are | Understand | CO 5 | AAEB02.15 |

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| | respectively 29 and 12 $W/m^2$ K, and the thermal conductivities of brick, foam, and wood are 0.98, 0.02, and 0.17 W /mK respectively, determine (a) the rate of heat removed by refrigeration if the total wall area is 90 $m^2$, and (b) the temperature of the inside surface of the brick. | | | |
| 5 | Water flows inside a tube 5 cm in diameter and 3 m long at a velocity 0.8 m/s. Determine the heat transfer coefficient and the rate of heat 1ra11sfer if the mean water temperature is 50°C and the wall i.s isothermal at 70°C. For water at 60°C, take K = 0.66 W/mK, v= 0.478 x t0·6m2/s, and Pr= 2.98. | Understand | CO 5 | AAEB02.15 |
| 6 | What is the optimum pressure ratio for perfect inter cooling in between two stages of compression? The inlet and outlet pressures may be taken as $P_1$ and $P_2$. | Remember | CO 5 | AAEB02.16 |
| 7 | A reciprocating air compressor has cylinder with 24 cm bore and 36 cm stroke. Compressor admits air at 1 bar, 17°C and compresses it up to 6 bar. Compressor runs at 120 rpm. Considering compressor to be single acting and single stage determine mean effective pressure and the horse power required to run compressor when it compresses following the isothermal process and polytropic process with index of 1.3. | Understand | CO 5 | AAEB02.16 |
| 8 | A single stage single acting reciprocating air compressor has air entering at 1 bar, 20°C and compression occurs following polytropic process with index 1.2 up to the delivery pressure of 12 bar. The compressor runs at the speed of 240 rpm and has L/D ratio of 1.8. The compressor has mechanical efficiency of 0.88. Determine the isothermal efficiency and cylinder dimensions. Also find out the rating of drive required to run the compressor which admits 1 $m^3$ of air per minute. | Understand | CO 5 | AAEB02.16 |
| 9 | A reciprocating compressor of single stage, double acting type delivers 20 $m^3$/min when measured at free air condition of 1 bar, 27°C. The compressor has compression ratio of 7 and the conditions at the end of suction are 0.97 bar, 35°C. Compressor runs at 240 rpm with clearance volume of 5% of swept volume. The L/D ratio is 1.2. Determine the volumetric efficiency taking the index of compression and expansion as 1.25. Also show the cycle on P-V diagram. | Understand | CO 5 | AAEB02.16 |
| 10 | A reciprocating compressor of single stage, double acting type delivers 20 $m^3$/min when measured at free air condition of 1 bar, 27°C. The compressor has compression ratio of 7 and the conditions at the end of suction are 0.97 bar, 35°C. Compressor runs at 240 rpm with clearance volume of 5% of swept volume. The L/D ratio is 1.2 find the dimensions of cylinder and isothermal efficiency taking the index of compression and expansion as 1.25. | Understand | CO 5 | AAEB02.16 |

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