# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad -500 043

## MECHANICAL ENGINEERING

## TUTORIAL QUESTION BANK

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| **Course Title** | **THERMODYNAMICS** | | | | |
| **Course Code** | AMEB04 | | | | |
| **Programme** | B. Tech | | | | |
| **Semester** | III | ME | | | |
| **Course Type** | Core | | | | |
| **Regulation** | IARE - R18 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | 1 | 4 | - | - |
| **Chief Coordinator** | Mr. A Venuprasad, Assistant Professor | | | | |
| **Course Faculty** | Dr. P Srinvasa Rao, Professor<br>Mr. A Venuprasad, 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 | Knowledge of properties during various phases of pure substances, mixtures, usage of steam tables and Mollier chart, psychometric charts. |
| III | Understand the direction law and concept of increase in entropy of universe. |
| IV | Understand the working of ideal air standard, vapor cycles and evaluate their performance in open systems like steam power plants systems. |
| V | Evaluate performance in internal combustion engines, gas turbines and refrigeration systems. |

## COURSE OUTCOMES (COs):

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| CO 1 | Describe the basic concepts and first law of thermodynamics. |
| CO 2 | Describe the second law of thermodynamics and understand the concept of entropy and third law of thermodynamics. |
| CO 3 | Understand the Pure Substances various thermodynamic processes. |
| CO 4 | Understand the concept of mixtures of perfect gases and psychometric properties. |
| CO 5 | Develop the concept power cycle with description and representation on P-V and T-S diagram. |

## COURSE LEARNING OUTCOMES (CLOS):

| S. No. | Description |
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| AMEB04.01 | Understand the concepts of conservation of mass, conservation of energy. |
| AMEB04.02 | Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like system properties, amount of work transfer and heat during various processes. |
| AMEB04.03 | Explore knowledge & ability to design the thermal related components in various fields of energy transfer equipment. |
| AMEB04.04 | Derive the first law of Thermodynamics from the concept of conservation of energy |
| AMEB04.05 | Discuss the nature of steady and unsteady processes under the influence of time. |
| AMEB04.06 | Determine entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations based on Carnot Cycle. |
| AMEB04.07 | Develop the second law of thermodynamics from the limitations of first law. |
| AMEB04.08 | Knowledge of the Gibbs and Helmholtz free energies as equilibrium criteria, and the statement of the equilibrium condition for closed and open systems. |
| AMEB04.09 | Discuss pressure-temperature, volume-temperature, pressure-volume phase diagrams and the steam tables in the analysis of engineering devices and systems. |
| AMEB04.10 | Understand the inter relationship between thermodynamic functions and an ability to use suchrelationships to solve practical problems. |
| AMEB04.11 | Understand the equation of state, specific and universal gas constants, throttling and free expansion processes. |
| AMEB04.12 | Discuss deviations from perfect gas model, Vander Waals equation of state. |
| AMEB04.13 | Understand mole fraction, mass friction, gravimetric and volumetric analysis, volume fraction. |
| AMEB04.14 | Discuss dalton‘s law of partial pressure, Avogadro‘s laws of additive volumes, and partial pressure, equivalent gas constant. |
| AMEB04.15 | Understand enthalpy, specific heats and entropy of mixture of perfect gases. |
| AMEB04.16 | Understand the process of psychrometry that are used in the analysis of engineering evices like air conditioning systems |
| AMEB04.17 | Develop Otto, Diesel, Dual combustion cycles, description and representation on P-V and T-S diagram. |
| AMEB04.18 | Discuss thermal efficiency; mean effective pressures on air standard basis. |
| AMEB04.19 | Understand the comparison of various cycles. |
| AMEB04.20 | Understand introduction to Brayton cycle and Bell Coleman cycle. |

**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. | Remember | CO 1 | AMEB04.01 |
| 2 | Define System, Surroundings and Boundary? | Understand | CO 1 | AMEB04.01 |
| 3 | Distinguish between macroscopic and microscopic point of view? | Remember | CO 1 | AMEB04.01 |
| 4 | Discuss Quasi Static process, what are its characteristics? | Remember | CO 1 | AMEB04.01 |
| 5 | Distinguish between different types of systems with examples. | Remember | CO 1 | AMEB04.01 |
| 6 | Explain the features of constant volume gas thermometer. | Remember | CO 1 | AMEB04.01 |
| 7 | Discuss First law of thermodynamics, explain Joule's experiment. | Remember | CO 1 | AMEB04.02 |
| 8 | Define PMM 1. | Remember | CO 1 | AMEB04.02 |
| 9 | State the causes of irreversibility? | Remember | CO 1 | AMEB04.02 |
| 10 | Derive Steady Flow Energy Equation, when the device is an aircompressor. | Remember | CO 1 | AMEB04.02 |
| 11 | State thermodynamic system? How do you classify it? | Remember | CO 1 | AMEB04.02 |
| 12 | State the closed system? Give an example | Remember | CO 1 | AMEB04.03 |
| 13 | Define Intensive and Extensive properties. | Understand | CO 1 | AMEB04.03 |
| 14 | Define equilibrium of a system? | Understand | CO 1 | AMEB04.03 |
| 15 | Define Intensive and Extensive properties. | Remember | CO 1 | AMEB04.03 |
| 16 | Differentiate closed and open system. | Understand | CO 1 | AMEB04.03 |
| 17 | Define Specific heat capacity at constant volume | Understand | CO 1 | AMEB04.04 |
| 18 | Define Specific heat capacity at constant pressure. | Remember | CO 1 | AMEB04.04 |
| 19 | Differentiate closed and open system. | Understand | CO 1 | AMEB04.04 |
| 20 | Classify the properties of system? | Remember | CO 1 | AMEB04.04 |
| **Part - B (Long Answer Questions)** | | | | |
| 1 | Differentiate the system, surroundings and boundary Explain in detail. | Remember | CO 1 | AMEB04.01 |
| 2 | Classify the types of systems; explain with examples. | Understand | CO 1 | AMEB04.01 |
| 3 | Distinguish between the macroscopic and microscopic study ofthermo dynamics? | Understand | CO 1 | AMEB04.01 |
| 4 | Explain the importance of concept of continuum in thermodynamicapproach? | Remember | CO 1 | AMEB04.01 |
| 5 | Explain thermodynamic equilibrium in detail? | Understand | CO 1 | AMEB04.01 |
| 6 | Differentiate thermal equilibrium and thermodynamic equilibrium, explain. | Understand | CO 1 | AMEB04.01 |
| 7 | Define property? What are different types of properties? Explain. | Understand | CO 1 | AMEB04.03 |
| 8 | Enumerate the Isobaric process from thermodynamic point of view? and derive its work done under p-Vcoordinates. | Remember | CO 1 | AMEB04.03 |
| 9 | Represent the Isochoric process from thermodynamic point ofview? and derive its work done under p-V coordinates. | Understand | CO 1 | AMEB04.03 |
| 10 | Enumerate the Isothermal process from thermodynamic point of view? and derive its work done under p-V coordinates. | Remember | CO 1 | AMEB04.03 |
| 11 | Represent the adiabatic process from thermodynamic point ofview? And derive its work done under p-V coordinates. | Understand | CO 1 | AMEB04.03 |
| 12 | Enumerate the polytrophic process from thermodynamic point ofview? And derive its work done under p-V coordinates. | Remember | CO 1 | AMEB04.03 |
| 13 | Derive the expression for piston displacement work with neatdiagram? | Understand | CO 1 | AMEB04.03 |
| 14 | State Zeroth law and explain with a example? | Understand | CO 1 | AMEB04.03 |
| 15 | Explain the Joule's experiment with a neat sketch? | Understand | CO 1 | AMEB04.03 |

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| 16 | Sketch the constant volume gas thermometer and explain? | Remember | CO 1 | AMEB04.03 |
| 17 | Derive exit velocity for nozzle by considering steady flow energyequation. | Understand | CO 1 | AMEB04.03 |
| 18 | Define path function and Show that work and heat are pathfunctions? | Remember | CO 1 | AMEB04.03 |
| 19 | Explain the first law of thermodynamics applied to closed systemwhen system undergoing a change of state? | Understand | CO 1 | AMEB04.03 |
| 20 | Derive the Steady flow energy equation? | Understand | CO 1 | AMEB04.03 |
| **Part - C (Problem Solving and Critical Thinking Questions)** | | | | |
| 1 | When a stationary mass of gas was compressed without friction at constant pressure, its initial state of 0.4$m^3$ and 0.105MPa was found to change to final state of 0.20$m^3$and 0.105MPa. There was a transfer of 42.5kJ of heat from the gas during theprocess. Determine the change in internal energy of the gas? | Remember | CO 1 | AMEB04.02 |
| 2 | 0.44kg of air at 180$^0$ C, expands adiabatically to 3times its original volume and during the process there is a fall in temperature to 15$^0$C. The work done during the process is 52.5kJ. Calculate Cp and Cv? | Understand | CO 1 | AMEB04.02 |
| 3 | Two thermometers one centigrade and other Fahrenheit are immersed in a fluid, after the thermometers reached equilibrium with the fluid, it is noted that both the thermometers indicate the same numerical values. Find that the identical numerical values shown by the thermometers? Determine the corresponding temperature of the fluid, express in degrees Kelvin and degrees Rankine? | Remember | CO 1 | AMEB04.02 |
| 4 | If a gas of volume 6000 $cm^3$ and at pressure of 100 kPa is compressed quasi statically according to $pV^2$ = constant until the volume becomes 2000 $cm^3$, determine the final pressure and the work transfer. | Remember | CO 1 | AMEB04.03 |
| 5 | A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 $m^3$ and 1.20 $m^3$.Thespecificinternalenergyofthegasisgivenbytherelationu=l.5p V–85kJ/kg.WherepisthekPaandvisinm3/kg. Calculatethe net heat transfer and the maximum internal energy ofthe gas attained during expansion. | Understand | CO 1 | AMEB04.03 |
| 6 | A piston cylinder device operates 1kg of fluid at 20atm pressure with initial volume is 0.04$m^3$. Fluid is allowed to expand reversibly following $pV^{1.45}$=C. So that the volume becomes double. The fluid is cooled at constant pressure until the piston comesback.Determine the work done in each process? | Remember | CO 1 | AMEB04.03 |
| 7 | A fluid contain in a horizontal cylinder with a frictionless leak proof piston is continuously agitated by a stirrer passing through the cylinder cover. The diameter of the cylinder is 50cm and the piston is held against the fluid due to atmospheric pressure equal to 100kPa. The stirrer turns 8000 revolutions with anaverage torqueof 1.5Nm. If the piston slowly moves outwards by 60cm. Determine the network transfer to the system? | Understand | CO 1 | AMEB04.03 |
| 8 | A Piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle the sum of all heat transfers is -170kJ. The system completes 100cycles/minute. Complete the following table showingthemethod for each item and compute net rate of work output in kW. | Understand | CO 1 | AMEB04.03 |
| 9 | A fluid is confined in a cylinder by a spring loaded friction less piston, so the pressure in the fluid is a linear function of volume (p=a+bV).The internal energy of the fluid is given by the following equation U=34+3.15pV. Where U is in kJ, p in kPa and V is in m3. If the fluid changes from initial state of 170kPa, | Remember | CO 1 | AMEB04.03 |

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| | 0.03$m^3$ to a final state of 400kPa, 0.06$m^3$ with no work other than that done on the piston. Define the direction and magnitude of work and heattransfer. | | | |
| 10 | Air flows steadily at the rate of 0.5kg/sec through an air compressor, entering at 7m/sec velocity, 100kPa pressure and 0.95$m^3$/kg volume and leaving at 5m/sec, 700kpa and 0.19$m^3$/kg. The internal energy of air leaving is 90kJ/kg greater than that of air entering. Cooling water in the compressor jacket absorbs heat from the air at the rate of 58kW.Compute the rate of shaft work input to the air in KW. | Remember | CO 1 | AMEB04.03 |
| **MODULE- II** | | | | |
| **LIMITATIONS OF FIRST LAW** | | | | |
| **PART - A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | State the limitations of first law of thermodynamics? | Understand | CO 2 | AMEB04.05 |
| 2 | Define second law of thermodynamics? | Understand | CO 2 | AMEB04.07 |
| 3 | State PMM 2? | Understand | CO 2 | AMEB04.05 |
| 4 | State the processes of Carnot Cycle? | Understand | CO 2 | AMEB04.07 |
| 5 | State the Clausius inequality? | Remember | CO 2 | AMEB04.05 |
| 6 | Define the absolute temperature scale? | Understand | CO 2 | AMEB04.05 |
| 7 | Define the property of entropy? | Remember | CO 2 | AMEB04.07 |
| 8 | Define an inversion curve? | Understand | CO 2 | AMEB04.05 |
| 9 | Write 1 and 2 Maxwell's relations? | Understand | CO 2 | AMEB04.09 |
| 10 | State the Third law of Thermodynamics? | Understand | CO 2 | AMEB04.07 |
| 11 | Define available energy of a system? | Remember | CO 2 | AMEB04.09 |
| 12 | Write 3 and 4 Maxwell's relations? | Remember | CO 2 | AMEB04.05 |
| 13 | Explain dead state of a system? | Understand | CO 2 | AMEB04.05 |
| 14 | Define the unavailable energy in a system? | Understand | CO 2 | AMEB04.05 |
| 15 | Explain the principle of entropy increase? | Understand | CO 2 | AMEB04.05 |
| 16 | Explain the exergy of a system? | Remember | CO 2 | AMEB04.09 |
| 17 | Explain the Claussius statement? | Remember | CO 2 | AMEB04.07 |
| 18 | State the Kelvin-Plank statement? | Remember | CO 2 | AMEB04.05 |
| 19 | Sketch the PV and TS diagrams of Carnot cycle. | Remember | CO 2 | AMEB04.05 |
| 20 | Classify the processes which constitute the cycle. | Remember | CO 2 | AMEB04.05 |
| **PART - B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Explain the limitations of First law of thermodynamics in detail? | Understand | CO 2 | AMEB04.05 |
| 2 | Define the terms thermal reservoir, source, and sink with a neat sketch? | Understand | CO 2 | AMEB04.07 |
| 3 | Explain the heat engine with a neat sketch? | Understand | CO 2 | AMEB04.07 |
| 4 | Explain the heat pump with a neat sketch? | Understand | CO 2 | AMEB04.07 |
| 5 | List the performance parameters of a system and explain in detail. | Understand | CO 2 | AMEB04.09 |
| 6 | Compare the first law and second law of thermodynamics with suitable examples? | Understand | CO 2 | AMEB04.09 |
| 7 | Explain the second law of thermodynamics with suitable ketches? | Understand | CO 2 | AMEB04.05 |
| 8 | Write the Kelvin-Plank statement and explain with an example? | Understand | CO 2 | AMEB04.09 |
| 9 | Write the Clausius statement and explain with an example? | Understand | CO 2 | AMEB04.09 |
| 10 | Write the Kelvin-Planck and Clausius statements and explain with sketches? | Understand | CO 2 | AMEB04.09 |
| 13 | State PMM1 and PMM2, in which manner both are different? | Understand | CO 2 | AMEB04.05 |
| 14 | Compare the relation with process and cycle? Explain. | Understand | CO 2 | AMEB04.07 |
| 15 | State the Carnot's principle? What is the importance of theprinciple, explain? | Understand | CO 2 | AMEB04.07 |
| 16 | State the Claussius inequality? Explain. | Understand | CO 2 | AMEB04.09 |
| 17 | Explain the influence of entropy on various parameters? | Understand | CO 2 | AMEB04.07 |
| 18 | Define Gibb's and Helmholtz's functions? Comparethe importance of them | Understand | CO 2 | AMEB04.09 |
| 19 | State the irreversibility and explain. | Understand | CO 2 | AMEB04.05 |
| 20 | Explain the Availability in a thermodynamic system with example. | Understand | CO 2 | AMEB04.07 |

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| **Part - C (Problem Solving and Critical Thinking Questions)** | | | | |
| 1 | A heat engine working on Carnot cycle converts 1/5th of the heat input into work. When the temperature of the sink is reduced by $80^0$C, the efficiency gets doubled. Determine the temperature of sink? | Understand | CO 2 | AMEB04.07 |
| 2 | A reversible heat engine is supplied with heat from two constant temperature sources at 900K and 600 K and rejects heat to a constant temperature at 300K to sink. The engine develops work equivalent to 91kJ/s and rejects heat at the rate of 56kJ/sec. Estimate (i) heat supplied by each source(ii) Thermal efficiency ofengine. | Understand | CO 2 | AMEB04.07 |
| 3 | A block of iron weighing 100 kg and having a temperature of 100°C is immersed in 50 kg of water at a temperature of 20°C. What will be the change of entropy of the combined system of iron and water? Specific heats of iron and water are 0.45 and 4.18 kJ/kgK respectively. | Understand | CO 2 | AMEB04.09 |
| 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 thecontinuous rate of 1.75kJ/sec. State the least power necessary to pump this heat out continuous? | Understand | CO 2 | AMEB04.09 |
| 5 | A heat engine is operating between two reservoirs 1000K and 300K is used to drive a heat pump which extracts heat from the reservoir at 300K at a rate twice that at which the engine rejects the heat to it. If the efficiency of the engine is 40% of the maximum possible and COP of heat pump is 50% of the maximum possible, then determine the temperature of the reservoir to which the heat pump rejects heat. Also determine the rate of heat rejectionfromthe heat pump, if the rate of heat supply to the heat engine is 50kW? | Understand | CO 2 | AMEB04.09 |
| 6 | Three Carnot engine are arranged in series. The first engine takes 4000kJ of heat from a source at 2000K and delivers 1800kJ of work. The second and third engines deliver 1200kJ and 500kJ of work respectively. Compare the exhaust temperature of second and third Carnot engines? | Understand | CO 2 | AMEB04.05 |
| 7 | Two bodies of equal capacities C and T1 and T2 from an adiabatically closed system. Determine the final temperature, if the system is brought to an equilibrium state. i) Freely, ii) reversibly, Proceed to calculate the maximum work which can be obtainedfrom the system? | Understand | CO 2 | AMEB04.05 |
| 8 | A heat engine is supplied with 2512kJ/min of heat at $650^0$C. Heat rejection takes place at $100^0$C. Distinguish which of the following heat rejection represent a reversible, irreversible or impossibleresult. i) 867 kJ/min ii) 1015 kJ/min iii) 1494 kJ/min | Understand | CO 2 | AMEB04.09 |
| 9 | Heat flows from a hot reservoir at 800K to another reservoir at 250K.If the entropy change of overall process is 4.25kJ/K, Compare calculation for the heat flowing out of thehightemperature reservoir? | Understand | CO 2 | AMEB04.09 |
| 10 | 5 kg of air heated from a temperature of 100 $^0$ C at constantvolume till its pressure becomes three times its original pressure.For this processcalculate :(i)heat transfer(ii)change in internal energy (iii)Change in enthalpy(iv)changeinentropyfor air take Cp=1.005kJ/kg k | Understand | CO 2 | AMEB04.05 |
| **MODULE -III** | | | | |
| **PURE SUBSTANCES** | | | | |
| **Part - A (Short Answer Questions)** | | | | |
| 1 | Define Pure Substance and what do you understand by a saturationstage? | Remember | CO 3 | AMEB04.13 |
| 2 | Draw the phase diagram on p-v diagrams with water as puresubstance? | Remember | CO 3 | AMEB04.13 |

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| 3 | Explain the concept of p-v-T surface? Represent on p-Tcoordinates? | Understand | CO 3 | AMEB04.13 |
| 4 | Explain the critical state of water? | Remember | CO 3 | AMEB04.13 |
| 5 | Draw the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property line? | Remember | CO 3 | AMEB04.13 |
| 6 | Draw the phase equilibrium diagram for a pure substance on H-s plot with relevant constant property line? | Understand | CO 3 | AMEB04.13 |
| 7 | Compare isobar on Mollier diagram diverse from one another? | Understand | CO 3 | AMEB04.13 |
| 8 | Explain Mollier chart by representing all the properties on it? | Remember | CO 3 | AMEB04.13 |
| 9 | State the degree of superheat and degree of sub cooling? | Understand | CO 3 | AMEB04.13 |
| 10 | Define dryness fraction? What are the different methods of measurement of dryness fraction? | Understand | CO 3 | AMEB04.13 |
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| 11 | Explain the equation of state? | Understand | CO 3 | AMEB04.15 |
| 12 | Derive the changes in internal energy during a process withvariable specificheats. | Remember | CO 3 | AMEB04.15 |
| 13 | Derive the changes in enthalpy during a process with variablespecific heats. | Remember | CO 3 | AMEB04.11 |
| 14 | Explain the process of free expansion? | Understand | CO 3 | AMEB04.11 |
| 15 | Explain the process of Throttling? | Remember | CO 3 | AMEB04.11 |
| 16 | State the expression for Vander Wall's equation and determine the constants? | Remember | CO 3 | AMEB04.11 |
| 17 | Explain On what coordinates compressibility charts can be drawn? | Understand | CO 3 | AMEB04.11 |
| 18 | List the molar specific heats, explain? | Remember | CO 3 | AMEB04.15 |
| 19 | Derive the expression for work done in a non-flow process, if the process is adiabatic? | Remember | CO 3 | AMEB04.15 |
| 20 | Discuss briefly the reduced properties? | Understand | CO 3 | AMEB04.11 |
| **Part – B (Long Answer Questions)** | | | | |
| 1 | Explain the procedure adopted in Steam calorimetry? | Understand | CO 3 | AMEB04.13 |
| 2 | Why can not a throttling calorimeter measure the quality, if the steam is wet? Explain how is the quality been measured? | Understand | CO 3 | AMEB04.13 |
| 3 | Explain the saturation temperature, the changes in specific volume, enthalpy and entropy during evaporation at 1MPa. | Understand | CO 3 | AMEB04.13 |
| 4 | Compare the enthalpy, entropy and volume of steam at 1.4MPa, $380^{O}$C. | Understand | CO 3 | AMEB04.13 |
| 5 | A vessel of volume 0.04$m^3$ contains a mixture of saturated water and saturated steam at a temperature of $250^{0}$C. The mass of theliquid present is 9kg.Find the pressure, mass, specific volume, enthalpy, entropy and internal energy? | Understand | CO 3 | AMEB04.13 |
| 6 | Steam initially at 1.5MPa, $300^{0}$C expands reversibly and adiabatically in a steam turbine to $40^{0}$C. Determine the ideal workoutput of the Turbine per kg of steam? | Understand | CO 3 | AMEB04.13 |
| 7 | Steam flows in a pipe line at 1.5MPa. After expanding to0.1MPain a throttling calorimeter, the temperature is found to be $120^{0}$C. Determine the quality of the steam in pipe line? | Understand | CO 3 | AMEB04.13 |
| 8 | The following data were obtained with a separating and throttling calorimeter. Pressure in pipe line is 1.5MPa. Condition after throttling is at0.1MPa, $110^{0}$C, During 5minutes moisture collected in the separator is 0.15lt at $70^{0}$C .steam condenses after throttling during 5 minis3.24kg, and Determine the quality of steam in the pipe line? | Understand | CO 3 | AMEB04.13 |
| 9 | Determine the enthalpy and entropy of steam and the pressure is2MPa and the specific volume is 0.09$m^3$/kg. | Understand | CO 3 | AMEB04.13 |
| 10 | Saturated steam has entropy of 3.56kJ/kg K. Determine the saturated pressure, temperature, specific volume, enthalpy. | Understand | CO 3 | AMEB04.14 |
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| 11 | Enumerate the Perfect Gas Laws and analyze | Understand | CO 3 | AMEB04.15 |
| 12 | Explain the equation of State with variations? | Understand | CO 3 | AMEB04.15 |
| 13 | Explain, how the heat and work transfer observed in perfect gas? | Understand | CO 3 | AMEB04.15 |

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| 14 | Explain the change in internal energy in perfect gas? | Understand | CO 3 | AMEB04.15 |
| 15 | State Vander Waals equation, what is the importance of it? | Understand | CO 3 | AMEB04.11 |
| 16 | What is compressibility chart, explain the procedure of usage? | Understand | CO 3 | AMEB04.15 |
| 17 | explain about law of corresponding states. | Understand | CO 3 | AMEB04.15 |
| 18 | what are the assumptions for deriving ideal gas equation. | Understand | CO 3 | AMEB04.15 |
| 19 | Derive the Clausius Claperon equation? | Understand | CO 3 | AMEB04.11 |
| 20 | Determine constants of vanderwaall's equation. | Understand | CO 3 | AMEB04.11 |
| | **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | 1 kg of water fills a 150 L rigid container at an initial pressure of 2MPa. The container is then cooled to 40$^{o}$C. Determine the initial temperature and final pressure of the water. | Understand | CO 3 | AMEB04.13 |
| 2 | Saturated steam has entropy of 6.76kJ/kg K. Determine the pressure, temperature, specific volume, enthalpy. | Understand | CO 3 | AMEB04.13 |
| 3 | A vessel of volume 0.04 m$^3$ contains a mixture of saturated water and steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume,enthalpy, entropy. | Understand | CO 3 | AMEB04.13 |
| 4 | A steam power plant uses steam at boiler pressure of 150 bars and temperature of 550°C with reheat at 40 bars and 550°Cat condenser pressure of 0.1 bar. Find the quality of steam at turbineexhaust, cycle efficiency and the steam rate. | Understand | CO 3 | AMEB04.13 |
| 5 | A large insulated vessel is divided in to two chambers. One is containing 5kg of dry saturated steam at 0.2MPa and other 10kg of steam, 0.8quality at 0.5MPa. If the partition between the chambers is removed and the steam is mixed thoroughly andallowto settle. Determine the final pressure steam quality and entropy change in the process? | Understand | CO 3 | AMEB04.13 |
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| 06 | The volume of a high altitude chamber is 40m$^3$.It is put into operation by reducing pressure from 1bar to 0.4bar and temperature from 25$^0$C to 5$^0$C. How many kg of air must be removed from the chamber during the process? Express this massas a volume measured at 1bar and 25$^0$C. | Understand | CO 3 | AMEB04.15 |
| 07 | A fluid at 200kPa and 300$^0$C has a volume of 0.8m$^3$ in a frictionless process at constant volume, the pressure changes to100kPa. Calculate the final temperature and heat transfer, if the fluid is air? | Understand | CO 3 | AMEB04.15 |
| 08 | A fluid at 250$^0$C and 300kPa is compressed reversibly and isothermally to 1/16th of its original volume. Calculate the final pressure, work done and change of internal energy per kg of fluid, if the fluid is air? | Understand | CO 3 | AMEB04.15 |
| 09 | Solve that for an ideal gas the slope of the constant volume line on the T-S diagram is more than that of the constant pressure line. | Understand | CO 3 | AMEB04.11 |
| 10 | At a temperature of 423K,1 kg of nitrogen occupies volume of200 liters. The gas undergoes constant expansion with fully resisted to a volume of 360 liters. Then the gasexpandedisothermally to a volume of 500 liters. Sketch the process on p-V and T-S diagram. Find out overall change in entropy. | Understand | CO 3 | AMEB04.15 |
| | **MODULE -IV** | | | |
| | **INTRODUCTION TO AIR CONDITIONING** | | | |
| | **Part – A (Short Answer Questions)** | | | |
| 1 | State Dalton's law of partial pressures? | Remember | CO 4 | AMEB04.16 |
| 2 | Compute the characteristic gas constant and the molecular weightof the gas mixture? | Remember | CO 4 | AMEB04.16 |
| 3 | Derive the expression for internal energy? | Remember | CO 4 | AMEB04.16 |
| 4 | Define mole fraction? | Remember | CO 4 | AMEB04.16 |
| 5 | Explain about volumetric and gravimetric analysis? | Understand | CO 4 | AMEB04.16 |
| 6 | Define dry bulb temperature, wet bulb temperature, dew | Remember | CO 4 | AMEB04.16 |

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| | pointtemperature and degree of saturation? | | | |
| 7 | Explain adiabatic saturation temperature? | Understand | CO 4 | AMEB04.16 |
| 8 | Explain psychometric charts while representing all the properties? | Understand | CO 4 | AMEB04.16 |
| 9 | Locate i) sensible heating ii)sensiblecooling iii) heating andiv)Heating and Dehumidification on psychometric chart? | Understand | CO 4 | AMEB04.16 |
| 10 | Define bypass factors represent adiabatic mixing of two air streamson psychrometric chart? | Understand | CO 4 | AMEB04.16 |
| 11 | State dry bulb temperature? | Remember | CO 4 | AMEB04.16 |
| 12 | State wet bulb temperature? | Understand | CO 4 | AMEB04.18 |
| 13 | Define specific humidity? | Understand | CO 4 | AMEB04.19 |
| 14 | Define relative humidity? | Understand | CO 4 | AMEB04.17 |
| 15 | Explain Psychrometric chart? | Remember | CO 4 | AMEB04.18 |
| 16 | State adiabatic saturation? | Understand | CO 4 | AMEB04.17 |
| 17 | Define degree of saturation? | Understand | CO 4 | AMEB04.18 |
| 18 | Obtain the expression for enthalpy of gas mixture? | Remember | CO 4 | AMEB04.19 |
| 19 | Define mass fraction? | Remember | CO 4 | AMEB04.18 |
| 20 | State the law of additive volumes? | Understand | CO 4 | AMEB04.19 |
| **Part – B (Long Answer Questions)** | | | | |
| 1 | Explain the Mole fraction and Massfraction in the Mixture ofPerfect gas? | Understand | CO 4 | AMEB04.16 |
| 2 | Explain Gravimetric Analysis of mixtures? | Understand | CO 4 | AMEB04.16 |
| 3 | Explain the Volumetric Analysis of mixtures? | Understand | CO 4 | AMEB04.16 |
| 4 | Explain the Dalton's law of partial pressure with an example? | Understand | CO 4 | AMEB04.16 |
| 5 | Explain the Avogadro's laws of additive volumes? | Understand | CO 4 | AMEB04.16 |
| 6 | Compare the Volumetric and Gravimetric Analysis of mixtures? | Understand | CO 4 | AMEB04.16 |
| 7 | Using definitions of mass and mole friction, derivea relationbetween them. | Understand | CO 4 | AMEB04.16 |
| 8 | Somebody claims that the mass and mole fraction for mixture of COo2 and N2O are identical. Is it true? Why? Explain. | Understand | CO 4 | AMEB04.16 |
| 9 | Explain Equivalent gas constant of a gas mixture? | Understand | CO 4 | AMEB04.16 |
| 10 | Explain Molecular internal energy of a gas mixture? | Understand | CO 4 | AMEB04.16 |
| 11 | Derive the expressions for enthalpy and entropy of a gas mixture? | Understand | CO 4 | AMEB04.17 |
| 12 | Are the dry bulb temperature and dew point temperature are same?Explain when they are same. | Understand | CO 4 | AMEB04.18 |
| 13 | Explain the various properties of psychrometry? | Understand | CO 4 | AMEB04.18 |
| 14 | Compare dry bulb temperature and wet bulb temperature with asketch? | Understand | CO 4 | AMEB04.17 |
| 15 | Explain the concept of dew point temperature? | Understand | CO 4 | AMEB04.19 |
| 16 | Differentiate the Relation between specific humidity and relativehumidity and derive the relation between them? | Understand | CO 4 | AMEB04.18 |
| 17 | Explain the degree of saturation with an example? | Understand | CO 4 | AMEB04.18 |
| 18 | Explain the adiabatic saturation. And compare with degree ofsaturation. | Understand | CO 4 | AMEB04.19 |
| 19 | Enumerate different psychrometric processes that are taking place. | Understand | CO 4 | AMEB04.19 |
| 20 | How will you construct psychrometric chart? | Understand | CO 4 | AMEB04.19 |
| **Part – C (Problem Solving and Critical Thinking)** | | | | |
| 1 | The analysis by weight of a perfect gas mixture at 200C and 1.3bar is 10%O2, 70% N2, 15%CO2 and 5%CO. For a reference state of 00C and 1bar, determine partial pressure of the constituent and gasconstant of mixture. | Understand | CO 4 | AMEB04.16 |
| 2 | In an engine cylinder a gas has a volumetric analysis of 13%CO2, 12.5%O2 and 74.5% N2. The temperature at the beginning of expansion is 9500C and gas mixture expands reversibly through a volume ratio of 8:1. According to the law pV1.2=constant. Calculate per kg of gas, the work done and the heat flow. Take Cp for CO2=1.235kJ/kg K and O2=1.088kJ/kg K and N2 is 1.172kJ/kg K. | Understand | CO 4 | AMEB04.16 |
| 3 | The following is the volumetric analysis of a producer gas: | Understand | CO 4 | AMEB04.16 |

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| | CO=28%, H2=13%, CH4=4%, CO2=4%, N2=51%. Thevalues Of Cp for the constituent CO, H2,H4,CO2,N2are29.27kJ/mol.K,28.89kJ/mol.K,35.8kJ /mol.K,37.2kJ/mol.K,29.14kJ/ mol.K respectively. Calculate the values ofCp, Cv for the mixture. | | | |
| 4 | Find the relative humidity and specific humidity for air at 30 $^0$ C and having dew point temperature of 150C.Represent on psychrometric Chart. | Understand | CO 4 | AMEB04.17 |
| 5 | A mixture of hydrogen and oxygen is to be made, so that the ratio of H2 to O2 is 2:1 by volume. If the pressure and temperature are 1bar and 250C, respectively. Calculate mass of oxygen requiredand volume of the container? | Understand | CO 4 | AMEB04.17 |
| 6 | Air at 10bar and a DBT of 400C and WBT of 360C. Computedegree of saturation, dew point temperature and enthalpy of the mixture? | Understand | CO 4 | AMEB04.19 |
| 7 | Atmospheric air at 1.0132bar has DBT of 320C and a WBT of260C. Compute partial pressure of the water vapor, specific humidity, dew point temperature and relative humidity? | Understand | CO 4 | AMEB04.18 |
| 8 | Air at 200C, 40% RH is mixed adiabatically with air at 400C,40%RH in the ratio of 1kg of the former with 2kg of later (on dry basis).Find the final condition of air? | Understand | CO 4 | AMEB04.19 |
| 9 | Saturated air at 210C is passed through a dryer, so that its finalrelative humidity is 20%. The dryer uses silica gel absorbent. The air is then pass through a cooler until its final temperature is 210C without a change in specific humidity. Find out i)the temperature of air at the end of the drying process, ii) the relative humidity atthe end of the cooling process, iii)The dew point temperature at the end of the drying process? | Understand | CO 4 | AMEB04.19 |
| 10 | An air water vapor mixture enters an adiabatic saturator at 30$^0$C and leaves at20$^0$C, which is the adiabatic saturation temperature? The pressure remains constant at 100kPa. Determine the relativehumidity and humidity ratio of the inlet mixture. | Understand | CO 4 | AMEB04.19 |
| | **MODULE -V** | | | |
| | **AIR CONDITIONING SYSTEMS** | | | |
| | **Part - A (Short Answer Questions)** | | | |
| 1 | Classify the assumptions to be made for the analysis of allairstandard cycles? | Understand | CO 5 | AMEB04.17 |
| 2 | State theProcessesin Otto cycle and represent on P-V and T-S diagrams? | Remember | CO 5 | AMEB04.17 |
| 3 | State the Processes in Constant pressure cycle and represent on P-V and T-S diagrams? | Understand | CO 5 | AMEB04.18 |
| 4 | What are the variable factors used for comparison of cycles? | Remember | CO 5 | AMEB04.18 |
| 5 | Draw the modified Otto cycle? How it differs from Otto cycle? | Remember | CO 5 | AMEB04.18 |
| 6 | Derive the air standard efficiency of Diesel cycle? | Remember | CO 5 | AMEB04.18 |
| 7 | Define mean effective pressure? | Understand | CO 5 | AMEB04.19 |
| 8 | Listfunctional parts of simple vapor compressionsystemrepresent the processes on T-S diagram? | Understand | CO 5 | AMEB04.19 |
| 9 | Sketch P-V and T-S diagrams of Bell-Coleman cycle whilerepresenting process and hence deduce its COP? | Understand | CO 5 | AMEB04.20 |
| 10 | Discuss limited pressure cycle, represent the processes of it on P-Vdiagram? | Understand | CO 5 | AMEB04.20 |
| 11 | Compare Otto cycle with Diesel cycle? | Remember | CO 5 | AMEB04.20 |
| 12 | Define the unit of refrigeration? | Understand | CO 5 | AMEB04.20 |
| 13 | Define COP of refrigeration? | Remember | CO 5 | AMEB04.19 |
| 14 | Draw the PV diagram of Otto Cycle? | Understand | CO 5 | AMEB04.19 |
| 15 | Represent Otto cycle on TS diagram. | Remember | CO 5 | AMEB04.19 |
| 16 | Draw the PV diagram of diesel Cycle? | Understand | CO 5 | AMEB04.18 |
| 17 | Draw the TS diagram of diesel Cycle? | Remember | CO 5 | AMEB04.18 |
| 18 | Write the processes involved in Brayton cycle. | Understand | CO 5 | AMEB04.19 |

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| 19 | Evaluate the performance of refrigeration cycle? | Remember | CO 5 | AMEB04.20 |
| 20 | Draw the PV and TS diagrams of dual combustion cycle? | Understand | CO 5 | AMEB04.20 |
| **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 type of engine? | Understand | CO 5 | AMEB04.20 |
| 2 | What is an air standard cycle? What are the limitations of airstandard cycle? State the assumptions to be taken for its analysis | Understand | CO 5 | AMEB04.20 |
| 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 5 | AMEB04.20 |
| 4 | State the characteristic of air cycles? And what is the use of airstandard cycle analysis | Understand | CO 5 | AMEB04.19 |
| 5 | Define air standard efficiency of an Otto cycle and show that the efficiency of Otto cycle is lower than that of Carnot cycle. | Understand | CO 5 | AMEB04.19 |
| 6 | Derive an expression for mean effective pressure of the Otto cycle? | Understand | CO 5 | AMEB04.20 |
| 7 | Derive an expression for air standard efficiency of diesel cycle | Understand | CO 5 | AMEB04.20 |
| 8 | Derive an expression for air standard efficiency of dual cycle | Understand | CO 5 | AMEB04.19 |
| 9 | What is the difference between Otto and Diesel cycle? Show that the efficiency of Diesel cycle is always lower than the efficiency ofthe Otto cycle for the same compression ratio. | Understand | CO 5 | AMEB04.19 |
| 10 | Show by graphs how the efficiency of Diesel cycle varies with compression ratio and cutoff ratio. | Understand | CO 5 | AMEB04.20 |
| 11 | Explain the dual combustion cycle? Why the cycle is also calledlimited pressure cycle? Represent on p-V and T-S diagrams. | Understand | CO 5 | AMEB04.20 |
| 12 | What are the processes involved in Otto cycle. Explain theirstandard efficiency of Otto cycle. | Understand | CO 5 | AMEB04.20 |
| 13 | Compare the Otto and Diesel cycles for same constant maximumpressure and same heat input. | Understand | CO 5 | AMEB04.20 |
| 14 | Compare the thermal efficiency of Otto and dual and diesel cycleson the basis of same compression ratio and same heat input? | Understand | CO 5 | AMEB04.20 |
| 15 | In an Otto cycle, the pressure at the beginning of the compressionis 1 bar and pressure at the end of compression is 15 bar. Calculate the pressure ratio and the air standard efficiency of engine. | Understand | CO 5 | AMEB04.19 |
| 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 aclearance volume of 1500 cc. with fuel cutoff occurring at 5% of the stroke. | Understand | CO 5 | AMEB04.20 |
| 17 | Describe the components of vapour compression system with thehelp of P-V and T-S diagram. | Understand | CO 5 | AMEB04.20 |
| 18 | Explain the following (i)Wet Compression (ii)Dry compression (iii)sub cooling (iv)superheating | Understand | CO 5 | AMEB04.20 |
| 19 | Derive cop of Bell-Coleman cycle with the help of processesrepresenting on p-V and T-S diagram? | Understand | CO 5 | AMEB04.20 |
| 20 | Derive the expression for air standard efficiency of Brayton cycle. | Understand | CO 5 | AMEB04.20 |
| **Part – C (Problem Solving and Critical Thinking)** | | | | |
| 1 | An air refrigeration open system operating between 1 M Pa and 100 k Pa is required to produce a cooling effect of 2000 kJ/min. Temperature of the air leaving the cold chamber is – 5°C and at leaving the cooler is 30°C. Neglect losses and clearance in the compressor and expander.<br>Determine :<br>i. Mass of air circulated per min. | Understand | CO 5 | AMEB04.19 |

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| | ii. Compressor work, expander work, and cyclework<br>iii. COP and power in kW required | | | |
| 2 | An engine working on Otto cycle has a volume of 0.45$m^3$ pressure 1bar and temperature 30$^0$C at the beginning of the compression stroke. At the end of the compression stroke the pressure is 11bar. 210kJ of heat is added at constant volume. Determine efficiencyand mean effective pressure. | Understand | CO 5 | AMEB04.18 |
| 3 | An engine with 200mm cylinder diameter and 300mm stroke working on theoretical diesel cycle. The initial pressure and temperatureofairusedare1barand27$^0$C.Thecutofis8%ofthestroke. 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. | Understand | CO 5 | AMEB04.19 |
| 4 | DeterminetheCompressionratio,ifefficiencyofanOttocycleis 60%and ɣ = 1.5?Aninventorclaimsthatanewheatcyclewilldevelop0.4kwfor aheatadditionof32.5kJ/min.Thetemperatureofheatsourceis1990 K and that of sink is 850K. Is his claim possible? | Understand | CO 5 | AMEB04.18 |
| 5 | A perfect gas undergoes a cycle which consists of following processes.<br>i) Heat rejection at constant pressure<br>ii) Adiabatic compression from 1bar and 270C to 4 bar<br>iii) heat addition at constant volume to a final pressure of 16bar<br>iv)adiabaticexpansion to 1bar.<br>Calculate work done per kg of gas and efficiency of the cycle. Take Cp = 0.92 andCv=0.7. | Understand | CO 5 | AMEB04.19 |
| 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.Assumethe engine working on Diesel cycle? | Understand | CO 5 | AMEB04.20 |
| 7 | An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is 0.00263$m^3$. The initial pressure and temperature are 1bar and 50$^0$C. The maximum pressure is limited to 25 bars. Find the air standard efficiency and the meaneffectivepressure of the cycle? Assume ideal conditions? | Understand | CO 5 | AMEB04.20 |
| 8 | 28tonnes of ice from and at 0$^0$C is produced per day in an Ammonia refrigerator. The temperature range in the compressor is from 25$^0$C to - 15$^0$C. The vapor is dry and saturated at the end of the compression and expansion valve is used. Assuming theC.O.Pof 62% of the theoretical. Calculate power required to drive the compressor? | Understand | CO 5 | AMEB04.19 |
| 9 | A Bell-Coleman refrigerator operates between pressure limits of 1bar and 8bar. Air is drawn from the cold chamber at 9$^0$C, compressed and then it is cooled to 29$^0$C before entering the expansion cylinder. Expansion and compression follow the law $pV^{1.35}$=C. Calculate theoretical C.O.P of the system. Take ɣ of airis 1.4. | Understand | CO 5 | AMEB04.20 |
| 10 | 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 65bar. Fuel injection ends at 5% of stroke. The temperature and pressure of the start of the compression are 80$^0$Cand 0.9bar. Determine air standard efficiency of cycle? Take ɣ of air is 1.4. | Understand | CO 5 | AMEB04.20 |

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