ME6301 - ENGINEERING THERMODYNAMICS - QUESTION BANK

III SEMESTER MECHANICAL AND AUTOMOBILE ENGG

UNIT-I: BASIC CONCEPT & FIRST LAW

PART –A

1. Define the term thermodynamics.
2. What is meant by thermodynamics system? How do you classify it?
3. What is meant by Continuum? Identify its importance.(Au-Nov''2009)
4. Define an open system Give an example. Define an isolated system:
5. Distinguish between Open and Closed system.(Anna univ.Oct'02)
6. Prove C_p-C_v=R.(Au-May'2009)
7. Define specific heat capacity at constant pressure.
8. Define specific heat capacity at constant volume.
9. What is meant by surroundings? What is boundary?
10. What is meant by PMM1?(Au-Apl'2004,Mu-Apl'2001)
11. What is meant by thermodynamic property? How do you classify the property?
12. Determine the molecular volume of any perfect gas at 600N/m^2 and 30°C. Universal gas constant may be taken as 8314J/Kg mole-K.
13. What is meant by reversible and irreversible prosess?(Mu-Apl'2001,Au-2004)
14. What is the requirement of thermal equilibrium? Which law governs it?(Mu-Apl'98,2004,2009)
15. Differentiate Intensive and Extensive properties.(Mu-Apr'99)
16. Define internal energy and enthalpy.(Mu-Oct'98,Apl'96)
17. Define process and cycle.(Mu-Nov'96)
18. State first law of thermodynamics. State zeroth law of thermodynamics(Au-Apl'2004)
19. What is Quasi-static process?.(Mu-Oct'98,Apl'2000,2001)
20. Difference between path and point functions.(Mu-Oct'2000)

16 MARK QUESTIONS

1.a.(i) The following data refered to a 12 cylinder, single acting, two stroke marine diesel engine. Speed = 150rpm; cylinder diameter = 0.8m; Stroke of piston = 1.2m; Area of indicator diagram = $5.5 \times 10^{-4} m^2$, length of the indicator diagram = 0.06m; spring value = 147MPa/m. Find the net rate of work transfer from the gas to piston in KW. (May'13)

(ii) A stationary mass of gas is compressed without friction from an initial state of $0.3 m^3$ and 0.105MPa to a final state of $0.15 m^3$ and 0.105MPa. There is a transfer of 37.6KJ of heat from the gas during the process. How much does the internal energy of the gas change? (May'13)

2. In a gas turbine the gas enters at the rate of 5 Kg/s with a velocity of 50m/s and enthalpy of 900KJ/kg and leaves the turbine with a velocity of 150 m/s and enthalpy of 400 KJ/kg. The loss of heat from the gas to the surroundings is 25 KJ/kg. Assume for gas R = 287 KJ/kg K and C_p = 1.004 KJ/kg K and the inlet conditions to be at 100KPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe. (May'13)

3. Air flows steadily at the rate of 0.5Kg/s through an air compressor, entering at 7 m/s velocity, 100 KPa pressure and 0.95 m^3/Kg volume and leaning at 5m/s, 700 KPa and 0.19m^3/Kg. the internal energy of the air leaving is 90 KJ/Kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 KW (i) compute the rate of shaft work input to the air in KW.(ii) Find the ratio of the inlet pipe diameter to the outlet pipe diameter.(Dec' 2012)

4. Derive the general steady flow energy equation and deduce SFEE for (i) Boiler (ii) Condenser and evaporator (iii) Nozzle (iv) Turbine and compressor. (Dec' 2012)

5. (i) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2MPa, temperature 188℃ , enthalpy 2785 KJ/Kg, velocity 33.3m/s and elevation 3m. The steam leaves the turbine at the following state: Pressure 20 MPa, temperature 188°C, enthalpy 2512 KJ/Kg, velocity 100m/s and elevation 0m. Heat is lost to the surroundings at the rate of 0.29 KJ/s. If the rate of steam flow through the turbine is 0.42 Kg/s, What is the power output of the turbine? (May 2010)

(ii) Prove that internal energy is a property. (May 2010)

6. (i) Prove that heat transfer in a polytrophic process is equal to W[$\frac{-}{\;-1}$] (May 2010)

(ii) A quantity of air having a volume of $0.04 m^3$ at a temperature of 250℃ and a pressure of 150N/cm^2 is expanded at constant pressure to $0.08 m^3$. It is then expanded at adiabatically to $0.12 m^3$. Find (i) Temperature and pressure at the end of the adiabatic process,(ii) Work done during each stage assume $= 1.41$.(May 2010)

7. A fluid is confined in a cylinder by a spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the 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 in cubic meter. If the fluid changes from an initial state of 170KPa,0.03m^3 to a final state of 400KPa,0.06m^3,with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.(Dec'2009)

8. Air contained in the cylinder and piston arrangement comprises the system. A cycle is completed by four process 1-2,2-3,3-4 and 4-1. The energy transfers are listed below. Compute the table and determine the net work in KJ. Also check the validity of the first law of thermodynamics. (Dec'2009)

Process	**Q(KJ)**	**W(KJ)**	**(KJ)**
1-2	40	?	25
2-3	20	-10	?
3-4	-20	?	?
4-1	0	+8	?

9. A stream of gases at 7.5bar, 750℃ and 140m/s is passed through a turbine of a jet engine. The steam comes out of the turbine at 2bar, 550℃ and 280m/s. The process may be assumer adiabatic. The enthalpies of gas at the entry and exit of the turbine are 950KJ/Kg 650KJ/Kg of gas respectively. Determine the capacity of the turbine if the gas flow is 5Kg/s.(Dec'2011)

10. (i) 1 Kg of ethane(perfect) gas is compressed from 1.1bar, 27℃ according to a law $Pv^{1.3}$ = constant, until the pressure is 6.6bar. Calculate the heat flow to or from the cylinder walls.

(ii) State the assumptions to be considered for steady flow energy equation and derive the SFEE for nozzle.

UNIT- II SECOND LAW

2 MARKS QUESTIONS

1. State the Kelvin - Planck statement of second law of thermodynamics.(Mu-Oct'2000)
2. State Clausius statement of second law of thermodynamics. (Mu-Apl-'2000,2009)
3. Write the two statements of the Second law of thermodynamics.(An- Apl-'2003)
4. State Carnot's theorem.(An-Oct'2002,2011,2009)
5. What are the Corollaries of Carnot theorems?(May'2013)
6. Define - PMM of second kind.(Mu-Apl'2000)
7. What is difference between a heat pump and refrigerator?(An-May-2011)
8. What is mean by heat engine? Why a heat engine cannot have 100% efficiency
9. Define the term COP.(May'2013)
10. Why Carnot cycle cannot be realized in steam power plant?(Mu-Apl'2001,Apl'2010)
11. Name two alternative methods by which the efficiency of a Carnot cycle can be increased.
12. Define availability of a given system?(May'2014)
13. When the Carnot cycle efficiency will be maximum?(May'2014)
14. What are the processes involved in Carnot cycle. (May'2012)
15. Define entropy. What are the characteristics of entropy?(May'2012)
16. State the limitations of I law of thermodynamics(Nov'2013)
17. Give an expression for entropy changes for an open system. (Nov'2013)
18. What is a temperature entropy diagram?
19. Why is the COP of an heat pump is higher than that of a refrigerator, if both operate between the same temperature limits?(Nov'2009)
20. What do you understand by dissipative effects? When work is said to be dissipated?(Au-Apl'2010)

16 MARKS QUESTIONS

1. A reversible engine is supplied with heat from two constant temperature sources at 900K and 600K and rejects heat to a constant temperature sink at 300K. The engine develops work equivalent to 90KJ/s and rejects heat at the rate of 56KJ/s. Estimate (i) Heat supplied by each source and (ii) Thermal efficiency of the engine.(Dec'2012)

2. Derive the efficiency of Carnot cycle and Explain with neat the help of p-v and t-s diagram.(Dec'2012)

3. A reversible heat engine operates between two reservoirs at temperatures of 600℃ and 40℃. The engine derives a reversible refrigerator which operates between 40℃ and -20℃. The heat transfer to the heat engine is 2000KJ and the net work output of the combined engine refrigerator plant is 360KJ. Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40℃.(Dec'2012)

4. Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200KJ at 421℃ while B is in communication with a cold sink at 4.4℃. If the work output of A is twice that of B. Find (i) the intermediate temperature between A and B(ii) efficiency of each engine (iii) heat rejected to cold sink.

5.(i) Deduce the efficiency of Carnot cycle in terms of temperature from its p-v diagram
(ii) Air is compressed from 100KPa and 300K to 5bar isothermally and then it receives heat at constant pressure. It is finally returns to its initial condition by a constant volume path. Plot the cycle on p-v and T-s diagram and calculate the net heat and work transfer.(Dec'2009)

6.(i) State and prove Clausius theorem.
(ii) A fluid undergoes a reversible adiabatic compression from 0.5MPa.0.2m^3 to 0.05m^3 according to the law $pv^{1.3}$= constant. Determine the change in entropy, change in internal energy and enthalpy. Also calculate the heat transfer and work transfer during the process.(Dec'2009)

7.(i) Prove that the efficiency of the Carnot cycle is $[(T_1-T_2)/T_1]$, where $T_1>, T_2$ and also draw the p-v and T-s diagram of Carnot cycle.
(ii) Derive the COP of the heat pump.(May'2010)

8. An ice plant working on a reversed Carnot cycle heat pump produces 15tonnes of ice per day. The ice is formed from water at 0℃ and the formed ice is maintained at 0℃. The heat is rejected to the atmosphere at 25℃. 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℃ by burning liquid fuel of 44500KJ/Kg calorific value and rejects the heat to the atmosphere. Determine(a)Power developed by the engine (b) Fuel consumed per hour.(Dec'2011)

9. A reversible heat engine operates between two reservoirs at temperatures of 700℃ and 50℃. The engine derives a reversible refrigerator which operates between 50℃ and -25℃. The heat transfer to the heat engine is 2500KJ and the net work output of the combined engine refrigerator plant is 400KJ. (i)Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50℃.(ii) Reconsider (i) given that the efficiency of the heat engine and the C.O.P of the refrigerator are each 45% of their maximum possible values.(Dec'2011)

10. One Kg of ice at -10℃ is allowed to melt in atmosphere at 30℃. The ice melts and the water so formed rises in temperature to that of atmosphere. Determine the entropy change of ice, the entropy change of surrounding, the entropy change of universe and write change of universe and write your comment based on principle of increase in entropy. The specific heat of ice is 2KJ/Kg-K and its latent heat is 335KJ/Kg.(Dec'2013)

UNIT –III (PROPERTIES OF PURE SUBSTANCES & STEAM CYCLE)

2 MARKS QUESTIONS

1. Define latent heat of ice.(Nov’2011)

2. What is pure substance?(Nov’2011)

3. What is saturation temperature and saturation pressure?(May’2011)

4. Define latent Heat of vaporization.(An-Nov-2009)

5. Find the saturation temp and latent heat of vaporization of steam at 1 Mpa.

6. Define the terms 'Boiling point' and 'Melting point .(May’2011)

7. What is meant by super heated steam? Indicate its use.(Nov’2013)

8. Define: sensible heat of water.(Nov’2013)

9. Define the term "Super heat enthalpy".(June’2009)

10. What are wet and dry steam?(June’2009)

11 . State phase rule of pure substances. ?(May’2008)

12. Define dryness fraction of steam (or) What is quality of steam?(May’2008)

13. Explain the terms: Degree of super heat, Degree of sub cooling.

14. Define triple point and critical point for pure substance.(Au-Apl’2010)

15. What is the triple point of water? Give the values of properties at that point. (May’2011)

16. What is mean by PVT surface? (May’2011)

17. Draw the T-S diagram for reheat cycle. (May’2010)
18. Define super heated steam. (May’2010)
19. What are the advantages of superheated steam? (Nov’2009).

20. Does the wet steam obey laws of perfect gases? (Nov’2009).

16 MARKS QUESTIONS

1. Wet steam of 0.5Mpa and 95% dry occupies 500litres of volume. What is its internal energy? If this steam is heated in a closed rigid vessel till the pressure becomes 1Mpa,find the heat added. Plot the process on Mollier chart. What is dryness fraction and degree of superheat?(Nov’2009).

2. A regenerative cycle with three open feed water heaters works between 3Mpa, 450°C and 4Kpa. Assuming that the bleed temperature are chosen at equal temperature ranges,plot the process on h-s diagram and determine the efficiency of the cycle. (Nov’2009).

3. A large insulated vessel is divided into two chambers, one containing 5kg of dry saturated steam at 0.2Mpa and the other 10kg of steam, 0.8dryness fraction at 0.5Mpa. If the partition between the chambers is removed and the steam is mixed thoroughly and allowed to settle, find the final pressure, steam quality, and entropy change in the process. (May’2010)

4. (a) Explain the process of regenerative cycle with help of suitable sketches and derive the expression for work output of the turbine. (b) Explain the terms degree of superheat and degree of sub cooling.(May’2010)

5. A vessel having a capacity of $0.05m^3$ contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10kg. Find the following(i) The pressure, (ii) The mass, (iii) The specific volume,(iv)The specific enthalpy,(v)The specific entropy, and(vi)The specific internal energy.(Nov-2011)

6. A pressure cooker contains 1.5kg of saturated steam at 5bar. 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.(Nov-2011)

7. Steam at 1Mpa and 0.9dry is throttled to a pressure of 200kpa.Using steam table, find the quality of steam and change in entropy, check your answer using Mollier chart? State whether this process is reversible or irreversible. (May’2011)

8. Steam at 0.8Mpa, 250°C and flowing at the rate of 1 kg/s passes into a pipe carrying wet steam at 0.8Mpa,0.95 dry. After adiabatic mixing the flow rate is 2.3kg/s. determine the condition of steam after mixing. The mixture is now expanded in a frictionless nozzle isentropic ally to a pressure of 0.4Mpa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in the pipeline.(Nov’2009)

9. (a).Draw P-V-T surface for any substance that contracts on freezing and get P-T pot out of them.(b) 3kg of steam at 18bar occupy a volume of $0.2550m^3$. During a constant volume process, the heat rejected is 1320KJ.Determine final internal energy. Find dryness fraction and pressure, change in entropy and work.(May'2008)

UNIT-IV (IDEAL & REAL GASES AND THERMODYNAMIC RELATIONS)

2 MARKS QUESTIONS

1. Determine the molecular volume of any perfect gas at 600N/m2 and 300 C. Universal gas constant may be taken as 8314J/kg mole-K.(May’2014)

2. State Boyle's law and Charle's law.(May’2014)

3. Is water vapour an ideal gas? Why?(An-Nov-2009)

4. State Joule's law and Regnault's law.(Nov’2008)

5. If atmospheric air (at 101325 Pa) contains 21% oxygen and 79% nitrogen (vol %), what is the partial pressure of oxygen. (Nov’2008)

6. State Avogadro's law.(Dec’2006)

7. State Dalton's law of partial pressure.(Dec’2006)

8. How does the Vander Waals equation differ from the ideal gas equation of state?(An-Apl’2010)

9. What is meant by virtual expansion?(May’2007)

10. Distinguish between ideal and real gas.(May’2007)

11.Define Joule-Thomson Co-efficient. What does the Joule-Thomson coefficient represent? (An-Apl’2010)

12. Define Co-efficient of volume expansion and Isothermal compressibility.(Nov’2006)

13. State Helmholtz function and Gibbs function?(Nov’2006)

14. What is compressibility factor? What does it signify? What is its value for an ideal gas at critical point?(Au-May’2010)

15. What is the value of the Clapeyron equation in thermodynamics?(May’2013)

16. What is the enthalpy departure? State Tds equations?(May’2013)

17. What are Maxwell relations?(Nov’2013)

18. Does the Joule-Thomson coefficient of a substance change with temperature at a fixed pressure?(Nov’2013)

19. Will the temperature of helium change if it is throttled adiabatically from 300 K and 600 kPa to 150 kPa?

20. What is the apparent molar mass for a gas mixture?

16 MARKS QUESTIONS

1. Derive Dalton’s law of partial pressure. Define Amagats law of partial volume.(May’2013)

2. Derive Vandar Waals equation. (May’2014)

3. Derive Maxwell’s equation (May’2014)

4. Derive the clausius-clayperon equation.5. A rigid tank contains 2 k mol of N2 and 6 k mol of CO2 gases at 300 K and 15 MPa (Fig. 13–10). Estimate the volume of the tank on the basis of(*a*) the ideal-gas equation of state, (*b*) Kay’s rule, (*c*) compressibility factorsand Amagat’s law, and (*d*) compressibility factors and Dalton’s law. .(Dec’2006)

6. An insulated rigid tank is divided into two compartments by a partition, as shown in Fig. 13–14. One compartment contains 7 kg of oxygen gas at 40°C and 100 kPa, and the other compartment contains 4 kg of nitrogen gas at 20°C and 150 kPa. Now the partition is removed, and the two gases are allowed to mix. Determine (*a*) the mixture temperature and (*b*) the mixture pressure after equilibrium has been established. .(Dec'2006)

7. An insulated rigid tank is divided into two compartments by a partition, as shown in Fig. 13–15. One compartment contains 3 k mol of O2, and the other compartment contains 5 kmol of CO2. Both gases are initially at 25°Cand 200 kPa. Now the partition is removed, and the two gases are allowed to mix. Assuming the surroundings are at 25°C and both gases behave as ideal gases, determine the entropy change and energy destruction associated with this process. Apl'2010)

8. Air is a mixture of N2, O2, and small amounts of other gases, and it can be approximated as 79 percent N2 and 21 percent O2 on mole basis. During a steady-flow process, air is cooled from 220 to 160 K at a constant pressure of 10 MPa (Fig. 13–17). Determine the heat transfer during this process per k mol of air, using (*a*) the ideal-gas approximation, (*b*) Kay's rule, and(*c*) Amagat's law. Apl'2010)

9. A rigid tank that contains 1 kg of N2 at 25°C and300 kPa is connected to another rigid tank that contains 3 kgof O2 at 25°C and 500 kPa. The valve connecting the two tanks is opened, and the two gases are allowed to mix. If the final mixture temperature is 25°C, determine the volume of each tank and the final mixture pressure.

10. A rigid tank contains 1 k mol of Ar gas at 220 K and 5 MPa. A valve is now opened, and 3 k mol of N2 gas is allowed to enter the tank at 190 K and 8 MPa. The final mixture temperature is 200 K. Determine the pressure of the mixture, using (*a*) the ideal-gas equation of state and (*b*) the compressibility chart and Dalton's law.

UNIT-V (PSYCHROMETRY)

2 MARKS QUESTIONS

1. What is the difference between air conditioning and refrigeration?
2. Define psychrometry.
3. Define dry bulb temperature (DBT).
4. Define wet bulb temperature.
5. Define dew point temperature.(Au-May'2009)
6. Define Relative Humidity (RH) and Specific humidity?(Au-Apl'2010,Nov'2009)
7. Differentiate between absolute and relative Humidity.(Au-Nov'2009)
8. Define DPT and degree of saturation.
9. What is dew point temperature? How is it related to dry bulb and wet bulb temperature at the saturation condition? .

10. State Dalton's law of partial pressure.(Au-May’2009)

11. Define Apparatus Dew Point (ADP) of cooling coil.

12. List down the psychrometirc processes. I

13. Define bypass factor (BPF) of a coil.

14. State the effects of very high and a very low bypass factor.

15. What are the assumptions made while mixing two air streams?

16. Define by pass factor.

17. Define dew point depression

18. Define wet bulb depression

19. What is need of sling psychrometer.

20. Define sensible heating

21.What is evaporative cooling?(Au-Apl’2010)

<u>PART-C</u> (16 marks)

1. Dry bulb and wet temperatures of 1 atmospheric air stream are 40°0 and 30°c respectively. Determine (a)Humidity (b) Relative humidity (c) Specific humidity(d) dew point temperature

2. Atmospheric air with barometric pressure of 1.013 bar has 38°c dry bulb temperature and *28°c* wet bulb temperature. Determine (a) Humidity ratio (b) Relative humidity *(c)*dewpoint temperature.

3. Atmospheric air at 760 mm of Hg has 45°c DBT and 30°c WBT, using psychometric chart calculate R.H, Humidity ratio, DPT, enthalpy, specific volume of air.

4.Atmospheric air at 1 bar pressure has 2.5°0 DBT and 75% RH using psychometric chart, calculate DBT, enthalpy, vapour pressure.

5. Explain sensible heating process, sensible cooling, and humidification process.

6. An air water vapour mixture at 0.1 Mpa, 30°0, 80% RH. Has a volume of 50 m3 Calculate the specific humidity, dew point, wet bulb temperature, mass of dry air and mass of water vapour.

7. Explain the various psychometric processes with neat sketch.

8. Consider a room that contains air at 1 atm, 35°C, and 40 percent relative humidity. Using the psychrometric chart, determine (*a*) the specific humidity, (*b*) the enthalpy, (*c*) the wet-bulb temperature, (*d*) the dew-point temperature, and (*e*) the specific volume of the air.

9. An air-conditioning system is to take in outdoor air at 10°C and 30 percent relative humidity at a steady rate of 45 m^3/ min and to condition it to 25°C and 60 percent relative humidity. The outdoor air is first heated to 22°C in the eating section and then humidified by the injection of hot steam in the humidifying section. Assuming the entire process takes place at a pressure of 100

Kpa, determine (*a*) the rate of heat supply in the heating section and (*b*) the mass flow rate of the steam required in the humidifying section.

10. Cooling water leaves the condenser of a power plant and enters a wet cooling tower at 35°C at a rate of 100 kg/s. Water is cooled to 22°C in the cooling tower by air that enters the tower at 1 atm, 20°C, and 60 percent relative humidity and leaves saturated at 30°C. Neglecting the power input to the fan, determine (*a*) the volume flow rate of air into the cooling tower and (*b*) the mass flow rate of the required makeup water.

11. A 5m X 5m X 3m room contains air at 25°C and 100 Kpa at a relative humidity of 75 percent. Determine

(a) The partial pressure of dry air
(b) The specific humidity
(c) The enthalpy per unit mass of the dry air
(d) The masses of the dry air and water vapour in the room

12. (a) 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 of 20°C and a relative humidity of 60% and leaves it at DBT at 28°Cand 90% relative humidity. Make up water is supplied at 20°C.

Determine

(a) The temperature of water leaving the tower
(b) The fraction of water evaporated
(c) The approach and range of the cooling water

(b) Write short notes on adiabatic mixing of two streams.(May;2013)

13. (i) How is the ratio of dry air flows related to specific humidity and enthalpy in an adiabatic mixing?

(ii)In a power plant, cooling water leaves the condenser and enters a wet cooling tower at 35°C at a rate of 100kg/s. water is cooled to 22.8 °C in the cooling tower by air that enters the tower at 101.325 KPa and 20°C and 60% relative humidity and leaves flow rate of air in to the cooling tower and mass flow rate of the required make up water.(May;2013)