**II B. Tech I Semester Regular Examinations, Jan - 2015**
**THERMODYNAMICS**
(Com. to ME, AE, AME)

Time: 3 hours Max. Marks: 70

Note 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**
4. Steam tables, Refrigeration Tables with Psychrometric chart are permitted

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**PART- A**

1. a) Explain about thermodynamic equilibrium.
   b) Why is the Carnot cycle on T-S plot a rectangle?
   c) Why the compression ratio of an S.I. engine cannot be increased beyond a certain limit?
   d) Why the entropy of an isolated system can never decrease?
   e) Explain Joules experiment
   f) Explain about relative humidity and specific humidity
   g) Explain about triple point (3M+3M+3M+3M+4M+3M+3M)

**PART- B**

2. a) Distinguish between the terms ‘Change of state’, ‘Path ’and ‘Process’.
   b) 0.5 kg of air is compressed reversibly and adiabatically from 80kPa, $60^0$C to 0.4 MPa, and is then expanded at constant pressure to the original volume. Sketch these processes on the p-v and T-s planes. Compute the heat transfer and work transfer for the whole path. (8M+8M)
3. a) Write the differential form of the steady flow energy equation and explain the terms.
   b) An axial flow compressor of a gas turbine plant receives air from atmosphere at a pressure 1 bar, temperature 300 $^0$K and velocity 60 m/s. At the discharge of compressor the pressure is 5 bar and the velocity is 100m/s. The mass flow rate through the compressor is 20kg/s. Assuming isentropic compression, calculate the power required to drive the compressor. Also calculate the inlet and outlet pipe diameters. (8M+8M)
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4. a) Demonstrate using the second law, that free expansion is irreversible.
   b) A block of iron weighing 100 kg and having a temperature of $100^0$C is immersed in 50 kg of water at a temperature of $20^0$C. What will be the change of entropy of combined system of iron and water? Specific heats of iron and water are 0.45 and 4.18 kJ/kg K respectively.
   (8M+8M)

5. a) What is steam quality? Develop relations for specific volume, enthalpy and internal energy for two-phase mixture.
   b) 10 kg of water at $45^0$C is heated at a constant pressure of 10 bar until it becomes superheated vapour at $300^0$C. Find the change in volume, enthalpy, internal energy and entropy.
   (8M+8M)

6. a) Distinguish between dry bulb temperature and wet bulb temperature that are used in Psychrometric chart.
   b) The barometer reads 750mm of Hg. The dry bulb temperature is $33^0$C and wet bulb temperature is $23^0$C. Calculate i) the relative humidity. ii) The humidity ratio and iii) Dew point temperature (6M+10M)

7. a) Explain the four processes of the Stirling cycle with PV and TS diagrams?
   b) A Diesel engine has a compression ratio of 14 and cut-off takes place at 6% of the stroke. Find the air standard efficiency? (8M+8M)



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**PART- A**

1. a) Explain about Quasi static process
   b) Explain zeroth and first law of thermodynamics
   c) Why does the fusion line for water have negative slope?
   d) Explain about critical point of steam
   e) Explain the concept of continuum
   f) Draw the P-V and T-S diagram of Otto cycle and indicate all the process
   g) Explain about Helmholtz function (3M+3M+4M+3M+3M+3M+3M)

**PART- B**

2. a) Distinguish between Path function and Point function.
   b) A mass of air is initially at $260^0$C and 700 kPa and occupies 0.028$m^3$. The air is expanded at constant pressure to 0.084 $m^3$. A polytropic process with n = 1.50 is then carried out, followed by a constant temperature process which completes a cycle. All the processes are reversible. i) Sketch the cycle in the p-v and T-s plane. ii) Find the heat received and heat rejected in the cycle, and iii) find the efficiency of the cycle. (6M+10M)
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3. a) Derive the steady flow energy equation to a open system and apply it to a heat exchanger.
   b) Explain the significance of Vander Waal's equation of state and derive its constants in terms of critical parameters. (8M+8M)

4. a) Explain the concept of principle of increase of entropy.
   b) Derive the four Maxwell's equations. (8M+8M)

5. Steam at 3 bar and 0.9 dry expands in a cylinder till the volume is four times that at the commencement. The law of expansion is $pv^{1.1} = c$. Determine the quantity of heat which must pass into or out of 1 kg of steam during the expansion. Also calculate the change in internal energy, amount of work done and condition of steam at the end of process. (16M)

6. a) State and explain the Dalton's law of partial pressure and Avogadro's law of additive volumes.
   b) The following volumetric composition relate to a mixture of gases: - $N_2 = 81\%$, $CO_2 = 11\%$, $O_2 = 6\%$, $CO = 2\%$
   Determine i) the gravimetric composition. ii) Molecular weight and
   iii) Universal gas constant R for the mixture. (8M+8M)

7. a) Explain the four processes of Ericsson cycle with PV and TS diagrams and derive an expression for its thermal efficiency.
   b) In the constant volume cycle the temperature at the beginning and end of the compression are $43^0C$ and $323^0C$ respectively. Calculate the i) air standard efficiency and ii) the compression ratio. Assume $\gamma = 1.4$ for air. (8M+8M)

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**PART- A**

1. a) Explain types of systems
   b) State the uses of generalized compressibility chart.
   c) Mention two practical examples for throttling process.
   d) How the wet bulb temperature is measured?
   e) Explain about Gibbs function
   f) Indicate the dryness fraction lines on L-S diagram of pure substance

(4M+4M+3M+3M+4M+4M)

**PART- B**

2. a) What is PMMI? Explain the device with a schematic diagram.
   b) If the temperature scale is graduated according to the equation $t = 100 + 3t_c$ where t is the temperature reading on the scale and $t_c$ is Celsius temperature. Find i) freezing and boiling point of the thermometric substance and ii) the absolute temperature corresponding to $20^0$ temperature reading on the scale. (6M+10M)
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3. a) Prove that energy is a property of the system.

   b) 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 $m^3$. The specific internal energy of the gas is given by the relation u = 1.5 pv – 85 kJ/kg where p is in kPa and v is in $m^3$/kg. Calculate the net heat transfer and maximum internal energy of the gas attained during expansion. (6M+10M)

4. a) Describe the processes of Carnot Cycle using PV and TS diagrams and derive an expression for its efficiency.

   b) Derive an expression for Clausius inequality and explain its utility. (8M+8M)

5. a) Describe the Mollier diagram and explain its uses.

   b) A vessel containing 5 kg of steam at 8 bar and $250^0$C is cooled by pouring water over the outer surface, till the inside pressure falls to 5 bar. Calculate i) the final state of the steam ii) heat loss iii) loss of internal energy. (6M+10M)

6. a) Explain the adiabatic saturation process using T-S diagram.

   b) Air at 1 bar has a dry bulb temperature of $25^0$C and wet bulb temperature of $15^0$C. Calculate i) the vapor pressure ii) the relative humidity iii) the specific humidity, iv) vapor density in air v) the dew point temperature and vi) the enthalpy of mixture. (6M+10M)

7. a) Explain the Lenoir cycle using PV and TS diagrams and derive an expression for its thermal efficiency.

   b) Describe the Bell-Coleman Cycle using PV and TS diagrams and derive an expression for its C.O.P. (8M+8M)



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Code No RT21033 **R13** SET - 4

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## PART- A

1. a) What are reduced co-ordinates? Write expressions for reduced pressure, reduced volume and reduced temperature.
   b) For the two absolute scales of temperature, give the values assigned the Ice point, triple point and steam point?
   c) What is PMM2?
   d) What is the difference between Brayton and Rankine cycles, which consist of similar processes?
   e) List the six psychrometric processes?
   f) List the four major components of a vapor compression refrigeration plant?
   g) What is degree of superheat? Indicate it using T – S diagram?
   h) Prove that heat transferred at constant volume increases the internal energy of the system.
   i) Write the limitations of first law of thermodynamics.

(2M+2M+2M+2M+2M+2M+2M+4M+4M)

## PART- B

2. a) Distinguish between Heat and Work?
   b) Describe the working of constant volume gas thermometer with a sketch? (8M+8M)
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3. a) With the help of T-P diagram, explain the throttling process.
   b) A steam turbine operates under steady-flow conditions. It receives 7200 kg/h of steam from the boiler. The steam enters the turbine at enthalpy of 2800 kJ/kg, a velocity of 4.000 m/min. and an elevation of 4m. The steam leaves the turbine at enthalpy of 2000 kJ/kg, a velocity of 8000 m/min and an elevation of 1m. Due to radiation, heat losses from the turbine the surrounding amount to 1580 kJ/h. Calculate the output of the turbine. (6M+10M)

4. a) Derive the relation: $T.ds = C_v \ dT + T.\left(\frac{\partial p}{\partial T}\right)_V .dv.$
   b) A heat engine receives half of its heat supply at 1000 K and half at 500K while rejecting at a sink 300K. What is the maximum thermal efficiency of the heat engine? (8M+8M)

5. a) Explain the procedure for calculating the steam quality using bucket calorimeter.
   b) Steam at a pressure of 6 bar with $41.2^0$C of superheat is expanded adiabatically and reversibly in a cylinder to 1 bar. Using steam tables, calculate the work done per kg of steam during the expansion and deduce the mean adiabatic index of expansion over this range. (8M+8M)

6. a) Define the following: i) Specific humidity ii) Relative humidity and iii) Saturation Ratio.
   b) An ideal-gas mixtures consists of 10 percent hydrogen, 48 percent oxygen and 42 percent carbon monoxide by weight. Calculate the volumetric analysis in percent and the apparent molar mass. (6M+10M)

7. a) Explain the four processes of Brayton Cycle with the help of PV and TS diagrams.
   b) In an ideal Brayton cycle, air from the atmosphere at 1 atm. 300 k is compressed to 6 atm and the maximum cycle temperature is limited to 1100k by using a large air-fuel ratio. If the heat supply is 100 MW, find i) the thermal efficiency of the cycle. ii) Work ratio iii) power outputs, and iv) energy flow rate of the exhaust gas leaving the turbine. (8M+8M)



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