II B. Tech I Semester Regular Examinations, Dec - 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**

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PART –A

1. a) What do you understand by macroscopic and microscopic view point?
   b) What is a heat pump? How does it differ from a refrigerator?
   c) What is Perpetual motion machine of the second kind?
   d) Explain law of corresponding states.
   e) In atmospheric air (at 101325 Pa) contains 21% oxygen and 79% nitrogen (vol. %), what is the partial pressure of oxygen?
   f) Explain Lenoir cycle.

PART -B

2. a) What is quasi-static process? Explain its characteristic features.
   b) A new scale N of temperature is divided in such a way that the freezing point ice is 100^0N and the boiling point is 400^0N. what is the temperature reading on this new scale when the temperature is 150^0C and 200^0C. Also determine at what temperature both the Celsius scale and the new temperature scale reading would be the same.

3. a) A gas undergoes a thermodynamic cycle consisting of the following processes.
   (i) process 1-2: constant pressure p=1.4 bar, V_1 = 0.028 m^3,W_{12}=10.5 kJ,
   (ii) process 2-3: compression with PV = constant, U_3=U_2,
   (iii) process 3-1: constant volume, U_1-U_3 = -26.4 kJ. There are no significant changes in K.E and P.E. (1) sketch the cycle on a P-V diagram. (2) Calculate the net work for the cycle in kJ. (3) Calculate the heat transfer for process 1-2 (4) show that $\Sigma Q_{cycle} = \Sigma W_{cycle}$.
   b) What is compressibility factor? Discuss about generalized compressibility chart.

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4. a) What is the maximum work obtained by using one finite body at temperature T and a thermal energy reservoir at temperature T_0, where $T>T_0$.
   b) A carnot heat engine receives heat from a reservoir at 1173 K at a rate of 800 kJ/min and reject the waste heat to the ambient air at 300 K. the entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at 268 K and transfers it to the same ambient air at 300 K. Determine the maximum rate of the heat removal from the refrigerated space and the total rate of heat rejection to the ambient air.

5. a) Draw the pv diagram of a pure substance and explain how it is formed.
   b) A large insulated vessel is divided in to two chambers, one containing 5 kg of dry saturated steam at 0.2 MPa and the other 10 kg of steam, 0.8 quality at 0.5 MPa. 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.

6. a) Explain about adiabatic evaporative cooling.
   b) Air at 40^0C DBT and 27^0C WBT is to be cooled and dehumidified by passing it over a cooling coil to a give a final condition of 15^0C and 90% RH. Find the amount of heat moisture removed per kg of dry air.

7. a) Explain the working of Otto cycle and derive the expression for thermal efficiency.
   b) A gas turbine plant operates on the brayton cycle between T_{min}=300K and T_{max}=1073K. Find the maximum work done per kg of air, and the corresponding cycle efficiency. How does this efficiency compare with the carnot cycle efficiency operating between same temperature limits.

Code No RT21033 **R13** SET - 2

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PART –A

1. a) Write the limitations of first law of thermodynamics.
   b) Explain steady flow process and variable flow process with examples.
   c) Define Heat engine. Derive its expression for efficiency.
   d) Explain Gibbs and Helmholtz functions.
   e) Draw the psychrometric chart and indicate its salient features.
   f) Explain sterling cycle.

PART -B

2. a) Explain the concept of continuum. How will you define density and pressure using this concept?
   b) A gas undergoes a reversible non-flow process according to the relation P = (-3V+15) where V is the volume in m^3 and P is the pressure in bar. Determine the work done when the volume changes from 3 m^3 to 6 m^3.

3. a) Write the steady flow energy equation and apply it to a turbine and heat exchanger.
   b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100kPa pressure, and 0.95 m^3/kg volume, and leaving at 5 m/s, 700 kPa, and 0.19 m^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 jacket 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 inlet pipe diameter to outlet pipe diameter.

4. a) Explain the second law of thermodynamics with an example.
   b) Calculate the entropy change of the universe as a result of the following processes: i) A copper block of 600 grams mass and with Cp of 150 J/kg-K at 100^0C is placed in a lake at 8^0C. ii)Two such blocks at 10^0 and 0^0C are joined together.

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5. a) What is P-V-T surface? Explain its salient features.
   b) A rigid cylinder of volume $0.028 m^3$ contains steam at 80 bar and 350^0C.The cylinder is cooled until the pressure is 50 Bar ,calculate
   i) The state of steam after cooling
   ii) The amount of heat rejected by the steam.

6. a) State and prove Avogadro's law of additive volumes.
   b) Cooling water enters the cooling tower at a rate of 1000 kg/h and 70^0C. Water is pumped from the base of the tower at 24^0C and some makeup water is added afterwards. Air enters the tower at 15^0C, 50% RH, 1.01325 bar and leaves the tower saturated at 34^0C, 1 bar. Calculate the flow rate of dry air in kg/h and the makeup water required per hour.

7. a) Explain the working of Diesel cycle and derive the expression for thermal efficiency.
   b) A gas turbine plant operates on the brayton cycle between T_{min}=300K and T_{max}=1173K. Find the maximum work done per kg of air, and the corresponding cycle efficiency. How does this efficiency compare with the carnot cycle efficiency operating between same temperature limits.

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PART –A

1. a) Explain the modes in which energy is stored in a system.
   b) What is PMM1? Explain why is it impossible?
   c) What is a thermal energy reservoir? Explain the terms source and sink.
   d) What is second law of thermodynamics? Write its corollaries.
   e) What is specific humidity? When does it become maximum.
   f) Indicate the processes of diesel cycle on a pv plot and write the expression efficiency.

PART –B

2. a) What do you understand by ideal gas temperature scale?
   b) A rigid tank containing $0.4m^3$ of air at 400 kPa and 30^0C is connected by a valve to a piston cylinder device with zero clearance. The mass of the piston is such that a pressure of 200 kPa is required to raise the piston. The valve is opened slightly and air is allowed to flow into the cylinder until the pressure of the tank drops to 200 kPa. During this process, heat is exchanged with the surrounding such that the entire air remains at 30^0C at all times. Determine the heat transfer for this process.

3. a) Derive the steady flow energy equation for a simple steady flow process and apply it to a steam nozzle.
   b) In a steady flow apparatus, 135 kJ of work is done by each kg of fluid. The specific volume of the fluid, pressuer and velocity at the inlet are 0.37 m^3/kg, 600kPa, and 16m/s. the inlet is 32 m above the floor and the discharge pipe is at floor level. The discharge conditions are 0.62 m^3/kg, 100kPa, and 270 m/s. The total heat loss between inlet and discharge is 9 kJ/kg of fluid. In this flow determine specific internal energy increases or decreases, and by how much.
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4. a) Establish the equivalence of Kelvin-Planck and Clausius statements.
   b) A fluid undergoes a reversible adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3 according to the law $pv^{1.3}$=const. Determine the change of enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process.

5. a) Derive Clausius-Clapeyron equation.
   b) Steam initially at a pressure of 10.5 bar 0.96 dry throttled to a pressure of 1 bar. Find the final condition of steam. Also calculate the change of entropy per kg of steam. Assume Cp for super heated steam = 2.1 KJ/kg. k

6. a) State and prove Daltons law of partial pressures.
   b) Atmospheric air at 1.0132 bar has a DBT of 32^0C and a WBT of 26^0C. Compute i) the partial pressure of water vapour, ii) Specific humidity, iii) Dew point temperature, iv) Relative humidity, v) Degree of saturation, vi) Density of air in the mixture, vii)Density of water vapour in the mixture.

7. a) With the help of a neat sketch explain the working of Rankin cycle and derive the expression for its thermal efficiency.
   b) A diesel engine has a compression ratio of 12 and cut-off takes place at 8% of the stroke. Find the air standard efficiency.

Code No RT21033 **R13** SET - 4

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PART –A

1. a) Explain the specific heats at constant volume and constant pressure.
   b) Discuss about thermodynamic equilibrium.
   c) What is a refrigerator? Derive its COP.
   d) What do you understand by triple point?
   e) Write the Maxwell's equations.
   f) Draw the block diagram of a simple rankine cycle and indicate the processes on a T-S plot.

PART -B

2. a) Show that heat transfer is a path function and not a property.
   b) Derive the expression for work done in a polytropic process
   c) A gas in a piston cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is given by PV^n= constant. The initial pressure is 0.3 MPa, the initial volume is 0.1 m^3 and the final volume is 0.2 m^3 Determine the work done by the process in kJ if n= 1.5.

3. a) Explain Joules experiment.
   b) A gas undergoes a thermodynamic cycle consisting of three processes beginning at an initial state where P_1=1 bar, V_1 = 1.5m^3 and U_1 = 512 kJ. The processes are as follows:
   (i) Process 1-2: Compression with PV=constant to P_2 = 2 bar, U_2 = 690 KJ
   (ii) Process 2-3: W_{2-3} =0, Q_{2-3}= - 152 KJ, and
   (iii) Process 3-1 : W_{3-1} = 55 KJ.
   Neglecting KE and PE changes, determine the heat interaction Q_{12} and Q_{31}.

4. a) Explain about inequality of Clausisu.
   b) An engine operating on a Carnot cycle works with in temperature limits of 600 K and 300 K. If the engine receives 2000 KJ of heat, evaluate the work done and thermal efficiency of the engine.

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5. a) With a neat sketch explain the working of throttling calorimeter.
   b) In a closed vessel the 100 kg of steam at 100 kPa, 0.5 dry is to be brought to a pressure of 1000 kPa inside vessel. Determine the mass of dry saturated steam admitted at 2000 kPa for raising pressure. Also determine the final quality.

6. a) Explain about cooling and dehumidification process.
   b) A gaseous mixture consists of 1 kg of oxygen and 2 kg of nitrogen at a pressure of 150 kPa and a temperature of 20^0C. Determine the changes in internal energy, enthalpy and entropy when the mixture is heated to a temperature of 100^0C, i) at constant volume and ii) at constant pressure.

7. a) With the help of a neat sketch explain the working of a simple vapour compression refrigeration cycle.
   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.