Code No: R1621033 **R16** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, October/November - 2018
THERMODYNAMICS
(Com to ME, AE and 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 **FOUR** Questions from **Part-B**

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PART –A

1. a) What is Zeroth law of thermodynamics? (2M)
   b) What is a steady flow process? (2M)
   c) What is a cyclic heat engine? (3M)
   d) What is a pure substance? Give example. (2M)
   e) Define mole fraction and mass fraction. (2M)
   f) Draw the P–V and T-S plots of Atkinson cycle and indicate all the processes. (3M)

PART -B

2. a) Explain the working of constant volume gas thermometer. (7M)
   b) A three process cycle operating with nitrogen as the working substance has constant temperature compression at 34^0C with initial pressure 100 kPa. Then the gas undergoes a constant volume heating and then polytropic expansion with 1.35 as index of expansion. The isothermal compression requires – 67 kJ/kg of work. Determine (7M)
   i) pressure, volume and temperature around the cycle
   ii) Heat in and out
   iii) Net work
   For Nitrogen gas C_V=0.7431 kJ/kg-K.

3. a) Explain Joule’s experiment. (7M)
   b) Derive the steady flow energy equation and apply in to a Heat exchanger. (7M)

4. a) A reversible heat engine operates between two reservoirs at temperatures of 600^0C and 40^0C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40^0C and -20^0C. The heat transfer to the engine is 2000 kJ and the net work output of the combined engine-refrigerator plant is 360 kJ. (10M)
   (i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40^0C.
   (ii) Reconsider (i) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible value.
   b) Explain about heat engine and heat pump (4M)

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5.	a)	Explain the working of throttling calorimeter.	(7M)
	b)	Steam initially at 2 MPa, 300^0C expands reversibly and adiabatically in a steam turbine to 50^0C. Determine the ideal work output of the turbine per kg of steam.	(7M)
6.	a)	A mixture of hydrogen (H_2) and oxygen (O_2) is to be made so that the ratio of H_2 to O_2 is 2:1 by volume respectively. Calculate i) the mass of O_2 required, ii) volume of the container.	(7M)
	b)	Air at 40^0C dbt and 27^0C wbt is to be cooled and dehumidified by passing it over a refrigerant filled coil to give a final condition of 15^0C and 90% RH. Find the amount of heat and moisture removed per kg of dry air.	(7M)
7.	a)	In an air standard diesel cycle, the compression ratio is 15, and at the beginning of isentropic compression, the temperature is 15^0C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480^0C. Calculate : i) Cutoff ratio, ii)heat supplied per kg of air, iii) cycle efficiency, iv) mean effective pressure.	(8M)
	b)	Explain the working of Bell Coleman cycle.	(6M)

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PART –A

1. a) What is PMM – I? (2M)

b) Show that energy is property of a system. (3M)

c) What is a heat pump? (2M)

d) Find the saturation temperature, entropy and enthalpy of steam at 1 MPa. (2M)

e) Define DBT and WBT. (2M)

f) Draw the P–V and T-S plots of Sterling cycle and indicate all the processes. (3M)

PART -B

2. a) Determine the heat transfer and its direction for a system in which a perfect gas having molecular weight of 6 is compressed from 101.3 kPa, 20^0C to a pressure of 600 kPa following the law $pV^{1.3}$ = const. Take the specific heat at constant pressure of gas as 1.7 kJ/kg.K. (6M)

b) Distinguish between reversible process and cyclic process. (4M)

c) Write the causes of irreversibility? (4M)

3. a) Derive the steady flow energy equation and apply in to steam nozzle and turbine. (8M)

b) Air enters an insulated diffuser operating at steady state with a pressure of 0.7 bar, a temperature of 5.7^0C and a velocity of 200 m/s. At the exit the pressure is 1 bar. The exit flow area is 20% greater than the inlet flow area. Potential energy effects can be neglected. Determine the air exit temperature and the velocity. Take C_P = 1.005 kJ/kg.K and R = 0.287 kJ/kgK. (6M)

4. a) Explain Carnot cycle. Write its specialties. (7M)

b) Two Carnot engines A and B are operated in series. The first one A receives heat at 900 K and reject to a reservoir at temperature T K. The second engine B receives the heat rejected by the first engine and in turn rejects to a sink at 400 K calculate the temperature T when (i) The efficiencies of the two engines are equal (ii) The work output of the two engines are equal (7M)
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5. a) A large insulated vessel is divided into two chambers; one contains 6 kg of dry saturated steam at 0.1 MPa and other 10 kg of steam 0.85 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. (10M)
   b) What do you understand by degree of superheat and degree of subcooling? (4M)

6. a) Explain Avogadro's law of additive volumes. (7M)
   b) Air at 20^0C, 40% RH is mixed adiabatically with air at 40^0C, 40% RH in the ratio of 1 kg of former with 2 kg of the latter (on dry basis). Find the final condition of air. (7M)

7. a) Compare Otto, Diesel and Dual cycles operating at same compression ratio, same maximum temperature and same maximum pressure. (7M)
   b) Explain the working of vapour compression refrigeration cycle. (7M)

Code No: R1621033 **R16** SET - 3

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3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Compare heat transfer with work transfer. (3M)
   b) What is first law of thermodynamics? (2M)
   c) Write the energy balance equation of a compressor? (2M)
   d) Find the saturation temperature, entropy and enthalpy of steam at 2 MPa. (2M)
   e) Define relative humidity and specific humidity. (2M)
   f) Draw the P–V and T-S plots of Otto cycle and indicate all the processes. (3M)

PART -B

2. a) Define the following terms: (6M)
   i) Thermodynamics
   ii) Macroscopic approach
   iii) Continuum.
   b) Define a new thermodynamic scale say degrees N, in which the freezing point and boiling point of water are 100^0N and 300^0N respectively. Correlate this temperature scale with centigrade scale. (8M)

3. a) Write the corollaries of first law of thermodynamics? (4M)
   b) Discuss about Vander waals equation of state. (4M)
   c) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate : (6M)
   (i) The rate at which heat is rejected to the turbine, and
   (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg.

4. a) What is the absolute thermodynamic temperature scale? Show that a definite point exists on the absolute temperature scale but that this point cannot be reached without the violation of the second law. (7M)
   b) Write the Maxwell's equations and derive the first and second Tds equations. (7M)

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5. a) Discuss about triple point and critical state. (5M)

   b) Steam at 0.8 MPa, 250^0C and flowing at a rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing the flow is 2.3 kg/s. Determine the condition of steam after mixing. (9M)

   The mixture is now expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in the pipeling.

6. a) Explain Daltons law of partial pressures. (5M)

   b) Atmosphere air at 1.0132 bar has a dbt of 32^0C and 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 vapour in the mixture, vii) enthalpy of the mixture. (9M)

7. a) The minimum pressure and temperature in a Otto cycle are 100 kPa and 28^0C. The amount of heat added to the air per cycle is 1400 kJ/kg. (i). Determine the pressure and temperatures at all points of air standard Otto cycle. (ii) thermal efficiency of the cycle for a compression ratio of 8:1. (7M)

   b) Explain the factors that affect the performance of vapour compression refrigeration cycle. (7M)

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PART –A

1. a) Show that energy of an isolated system remains constant. (2M)
   b) Write the differential form of steady flow energy equation. (2M)
   c) Write the corollaries of first law of thermodynamics? (3M)
   d) Discuss about triple point. (2M)
   e) Write Carrier's equation? (2M)
   f) Draw the P–V and T-S plots of Dual combustion cycle and indicate all the processes. (3M)

PART -B

2. a) Discuss about Macroscopic and Microscopic viewpoints. (6M)
   b) A gas of mass 1.5 kg undergoes a quasistatic expansion which follows the 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 0.2 m^3 and 1.2 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. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. (8M)

3. a) Write the limitations of first law of thermodynamics. (4M)
   b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate : (6M)
   (i) The rate at which heat is rejected to the turbine, and
   (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m3/kg.
   c) Apply steady flow energy equation to a Nozzle and throttling device. (4M)

4. a) Define Kelvi –Planck and Clausius statements. Prove that violation one Statement leads to a violation of the other Statement. (7M)
   b) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat for the reservoir at 300 K at a rate twice at which the engine rejects heat to it. If the efficiency of the engine is 40% of the maximum possible and the COP of the heat pump is 50% of the maximum possible, what is the temperature of the reservoir at which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 KW. (7M)
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5. a) A mass of wet steam at temperature 165^0C is expanded at constant quality 0.8 to pressure 3 bar. It is then heated at constant pressure to a degree of superheat 65^0C. Find the enthalpy and entropy changes during expansion and during heating. Draw the T – s and h – s diagrams. (9M)
   b) Explain P – T disgram of a pure substance. (5M)

6. a) A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon dioxide at a pressure of 300 kPa and a temperature of 20^0C. Find i) the mole fraction of each constituent, ii) the equivalent molecular weight of the mixture, iii) the equivalent gas constant of the mixture, iv) the partial pressures and partial volumes, v) volume and density of the mixture, vi) C_P and C_V of the mixture. (10M)
   If the mixture is heated at constant volume to 40^0C, find the internal energy, enthalpy and entropy of the mixture. Find the changes in internal energy, enthalpy and entropy of the mixture if the heating is done at constant pressure. Take γ for CO_2 and N_2 as 1.286 and 1.4 respectively.
   b) Explain psychrometric chart. (4M)

7. a) An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following : (8M)
   (i) The air standard efficiency of the cycle.
   (ii) The mean effective pressure for the cycle.
   Assume the ideal conditions
   b) Explain the working of reversed Brayton cycle. (6M)