Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

PDDC SEM-I Examination-Dec-2011

Subject code: X11902 **Date: 23/12/2011**

Subject Name: Engineering Thermodynamics

Time: 10.30 am -1.00 pm **Total marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of compressibility chart is permitted.**

Q.1 **(a)** Define/State/Explain in short the following terms. **07**

(1) Engineering Thermodynamics
(2) Pure substance
(3) Specific heat
(4) Control volume
(5) Enthalpy
(6) Dead state
(7) Temperature

(b) Derive the simple steady flow energy equation for single stream of mass enter and exit, to and from control volume respectively and with heat supply to C.V. and work output from C.V. **07**

Q.2 **(a)** Prove the equivalence of Kelvin-Planck and Clausius statements of second law of thermodynamics. **07**

(b) A centrifugal air compressor delivers 10 kg of air per minute. **07**
The intake / inlet conditions are as follows.
Inlet velocity = 10 m/s
Inlet pressure = 1 bar
Specific volume = 0.5 m^3/kg
The outlet conditions are as follows.
outlet velocity = 90 m/s
outlet pressure = 10 bar
Specific volume = 0.10 m^3/kg
The increase in enthalpy of air passing through compressor is 200 kJ/kg and heat losses to the surroundings is 800 kJ/min.
Calculate:
(1) The power required to drive the compressor
(2) The ratio of inlet to outlet pipe diameter
Assume that inlet and discharge lines at the same level.

OR

(b) A vessel of 10 m^3 capacity contains two gases A and B in proportion of 35% and 65% respectively at 30^0 C. If the value of R for the gases is 0.290 kJ/kg K and 0.296 kJ/kg K and if the total weight of the mixture is 3.5 kg, Determine **07**

(1) The partial pressures of gases
(2) The total pressure
(3) The mean value of R for the mixture.

Q.3 **(a)** Explain with neat sketch Carnot heat pump. Draw cycle on p-v diagram and derive COP for the same. **07**

(b) A heat pump absorbs heat from surrounding atmosphere and supplies 70 kJ/s to a house for heating in winter. The work input to heat pump is 10 kW. Calculate the COP of the heat pump. If the same heat pump is used to cool the house in summer requiring 70 kJ/s of heat rejection. Calculate its COP. Write the comment on the result. **07**

OR

Q.3 **(a)** Explain with neat sketch Carnot cycle. Draw cycle on p-v diagram and derive efficiency for the same. **07**

(b) An engine manufacturer claims to have developed an engine that receives 600 kJ of heat from a reservoir at 450^0 C and rejects 250 kJ heat to reservoir at 90^0 C and producing 280 kJ of work. Is the claim of manufacture is true or false? Give the reason for your answer. **07**

Q.4 **(a)** Explain available energy, unavailable energy, availability, high grade energy, low grade energy **07**

(b) Explain and derive with neat sketches available energy and unavailable energy referred to an infinite heat source i.e. TER (heat reservoir) **07**

OR

Q.4 **(a)** For Diesel cycle derive an equation for air standard efficiency. **07**

(b) An engine operating on Diesel cycle has maximum pressure and temperature is 50 bar and 1600^0 C respectively. The pressure and temperature at the beginning of the compression are 1 bar and 27^0 C respectively. Determine air standard efficiency of the cycle. Take $\gamma = 1.4$ for air. **07**

Q.5 **(a)** Explain stoichiometric equation, stoichiometric air excess air **07**

(b) Explain with necessary chemical reaction equations. **07**

(1) Stoichiometric air requirement for combustion of Carbon to Carbon Dioxide by gravimetric analysis
(2) Stoichiometric air requirement for combustion of Carbon to Carbon Dioxide by volumetric analysis

OR

Q.5 **(a)** Explain reduced propertied. Write Vander Waal's equation in terms of reduced properties. **07**

(b) Calculate the density of N_2 at 240 bar and 20^0 by using the compressibility chart. The critical pressure and temperature as 33.94 bar and 126.2 K respectively for N_2. **07**

Take Universal gas constant 8314 J/kg K.

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Compressibility chart