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BME-019

B. TECH. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING) (BTMEVI)

Term-End Examination

June, 2019

BME-019 : ENGINEERING THERMODYNAMICS

Time : 3 Hours *Maximum Marks : 70*

***Note** : Attempt **seven** questions in all. Questions no. 1 is **compulsory**. All questions carry equal marks. Use of scientific calculator and steam table is allowed.*

1. Choose the correct answer from the given four alternatives : 10×1=10

   (i) The Kelvin temperature of a system can be measured by a :

   (a) Mercury-in-glass thermometer

   (b) Thermocouple

   (c) Constant-volume gas thermometer

   (d) Resistance thermometer

   (ii) Heat transferred to a closed stationary system at constant volume is equal to :

   (a) work transfer

   (b) increase in internal energy

   (c) increase in enthalpy

   (d) increase in Gibbs function

(iii) The specific heats of an ideal gas C_P and C_V :

(a) vary with temperature

(b) vary with pressure

(c) vary with both pressure and temperature

(d) are constant

(iv) If the thermal efficiency of a Carnot engine is $\frac{1}{5}$, the COP of a Carnot COP of a refrigerator is :

(a) 5

(b) 4

(c) 6

(d) 3

(v) Two insulated tanks containing ideal gases at different pressure and temperatures are connected to each other and gases are allowed to mix. The process that occurs can be called :

(a) free expansion

(b) constant enthalpy

(c) constant internal energy

(d) reversible adiabatic

(vi) The work done by an ideal gas undergoing polytropic expansion from state 1 to state 2 is :

(a) $\frac{n(p_1v_1 - p_2v_2)}{n-1}$

(b) $\frac{p_2v_2 - p_1v_1}{n-1}$

(c) $\frac{p_1v_1 - p_2v_2}{n-1}$

(d) $\frac{p_1v_1 - p_2v_2}{\gamma-1}$

(vii) An ideal gas at 27°C is heated at constant pressure till the volume becomes three times. The temperature of the gas will then be :

(a) 81°C

(b) 900°C

(c) 627°C

(d) 927°C

(viii) Match List I with List 2 and choose the correct answer from the code :

	List 1		**List 2**
	Law of thermodynamics		**Defines**
(A)	First	(i)	Internal Energy
(B)	Second	(ii)	Temperature
(C)	Zeroth	(iii)	Entropy

Code :

	(A)	(B)	(C)
(a)	(iii)	(i)	(ii)
(b)	(ii)	(iii)	(i)
(c)	(i)	(iii)	(ii)
(d)	(i)	(ii)	(iii)

(ix) The efficiency of a Carnot engine is given as 0.75. If the cycle direction is reversed, what will be the value of COP (heat-pump) of reversed Carnot cycle ?

(a) 0.75

(b) 1.33

(c) 0.33

(d) 0.25

(x) The process involved in a Carnot cycle are :

(a) two adiabatic processes and two constant volume processes

(b) two adiabatic processes and two isothermal processes

(c) two isothermal and two constant pressure processes

(d) two constant pressure and two constant volume processes

2. (a) What is an ideal gas ? What is the difference between the universal gas constant and a characteristic gas constant ? 5

   (b) An engine cylinder has a piston of area 0.12 m^2 and contains gas at a pressure of 1.5 MPa. The gas expands according to a process which is represented by a staright line on a pressure-volume diagram. The find pressure is 0.15 MPa. Calculate the work done by the gas on the piston if the stroke is 0.30 m. 5

3. A single cylinder, single-acting, 4 stroke engine of 0.15 m bore develops an indicated power of 4 kW when running at 216 rpm. Calculate the area of the indicator diagram that would be obtained with an indicator having a spring constant of 25×10^6 N/m^3. The length of the indicator diagram is 0.1 times the length of the stroke of the engine. 10

4. 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. 10

   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 of the process in kJ if :

(i) $n = 1.5$

(ii) $n = 1.0$

(iii) $n = 0$

5. (a) State and explain the first law of thermodynamics for a closed system undergoing a change of state. 5

(b) A cyclic heat engine operates between a source temperature of 800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine ? 5

6. (a) State and explain the Clausius' statement of the second law of thermodynamics. 5

(b) What is a reversible process ? What are the causes of irreversibility of a process ? 5

7. Two reversible heat engines A and B are arranged in series. A rejecting heat directly to B. A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find : 10

(a) The intermediate temperature between A and B

(b) The efficiency of each engine

(c) The heat rejected to the cold sink.

8. A reversible engine works between three thermal resources A, B and C. The engine absorbs an equal amount of heat from the thermal reservoirs A and B kept at temperatures T_A and T_B respectively and rejects heat to the thermal reservoir C kept at temperature T_C. The efficiency of the engine is α times the efficiency of the reversible engine, which works between the two reservoirs A and C. Prove that :

$$\frac{T_A}{T_B} = (2\alpha - 1) + 2(1 + \alpha)\frac{T_A}{T_C}.$$

9. (a) What do you understand by triple point ? Explain with the help of a neat diagram. 5

   (b) A rigid closed tank of volume $3\,m^3$ contains 5 kg of wet stream at a pressure of 200 kPa. The tank is heated until the stream becomes dry saturated. Determine the final pressure and the heat transfer to the tank. 5

10. (a) Why is Carnot cycle not practicable for a stream power plant ? 5

    (b) When is reheating of stream recommended in a stream power plant ? What is the effect of reheat on the cycle efficiency of a steam power plant ? 5