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F.Y. B. Tech.

ME 101- BASIC THERMODYNAMICS

[Time : 3 Hours] [Max. Marks: 60]

Instructions to candidates:

(1) Answer any four questions.
(2) Assume suitable data, if necessary.
(3) Figures to the right indicate full marks.
(4) Use of Logarithmic tables, Mollier charts, Non-programmable electronic calculators and Steam tables is allowed.
(5) Answer of every question should start on new page.
(6) The question number **6** includes exercises on multiple-choice objective items; all exercises in this question ought to be attempted collectively (as a group at one place) and at one time only (no exercise shall be attempted twice).

Qu. 1 **(a)** Make clear the meaning and give examples of **4**
- Conventional energy sources, and
- Non-conventional or alternative energy sources.

(b) Draw a layout of hydraulic power plant. Also give a simple sketch of any of the reaction turbines. **4**

(c) A Carnot cycle operates between temperatures of 4·4 C and 32·2 C. Investigate the effectiveness (respectively in terms of COP & η) of this cycle when its purpose is **7**
A To provide refrigeration
B To deliver power.

Qu. 2 **(a)** Write a short note on solar energy. **4**

(b) What is a macroscopic, and a microscopic approach for the analysis of a thermodynamic problem? **4**

(c) Entropy of 1 kg of steam at 5 bars is 5 kJ/kg-deg. Calculate the heat spent **q** measured from water at 0^{o} C to this final condition. **7**

Qu. 3 **(a)** Explain the working principle of domestic refrigerator. **4**

(b) Explain the concept of entropy. **4**

(c) Elucidate the First law of thermodynamics and describe the related Joule's experiment. **7**

Qu. 4 **(a)** Distinguish between **4**
- Intensive properties and extensive properties,
- Heat and work

(b) Calculate the mass of air at STP (273·15 K; 101325 Pa) in a room of dimensions **5**m x **5**m x **3·1**m. Take **28·97** kg/kmol as molecular mass of air. Compare your results with the mass of water it would acquire to fill the room. **4**

(c) 5000 kg of *Liquid A* (c_p 2.4 kJ/kg-deg) per hour is cooled from 90 C to 60 C through a counter flow heat exchanger. *Liquid B* (c_p 1.7 kJ/kg-deg) is used as coolant, which is available at 35 C. The heat transfer surface area is 5 m^2. If the flow rate of coolant is 4000 kg/hr, determine 7

- Outlet temperature of the coolant.
- Overall heat transfer coefficient.

Qu. 5 (a) Two well-known statements of Second Law of thermodynamics- one on the conversion of heat energy, and other about the transfer of heat appear to be unconnected at first sight, but in fact, they are equivalent in all respects. Write down the statements and establish their equivalence. 5

(b) A nozzle is used to increase the velocity of steady flow stream. The parameters at inlet and exit from the nozzle are given 5

Parameters	**Inlet**	**Exit**
Enthalpy	3000 kJ/kg	2770 kJ/kg
Velocity	60m/s	?
Area	0·1 m^2	?
Specific volume	0·185	0·495 m^3/kg

Calculate velocity of fluid as it leaves the nozzle, rate of flow of fluid, exit area of the nozzle. Assume the nozzle horizontal and neglect heat loss.

(c) Sketch any particular boiler, label the parts, and explain the steam-water circuit and flue gas circuit. 5

Qu. 6 (I) In the exercises given below the two individual statements are connected by a word **"because"** to form an item. 12

The candidate has to decide – whether first statement called assertion and second statement called reason are individually **true or not,** and if they are true whether the reason is a valid explanation of the assertion.

There are 5 possible options (**A, B, C, D,** or **E**) available to the students to choose from; which are-

A. Both assertion and reason are **true** and reason is correct explanation of the assertion.

B. Both assertion and reason are **true** but reason is not correct explanation of the assertion.

C. The assertion is **true** but the reason is **false.**

D. The assertion is **false** but the reason is **true.**

E. Both assertion and reason are **false** statements.

Select the appropriate option and write the alphabet ' ' as answer.

(All exercises carry equal marks).

1. Water vapor in a rigid container at a pressure p and separated from the surroundings by an adiabatic wall forms an isolated system.	**Because**	An isolated system can have no interaction with the surrounding.
2. The state of the wet vapor can be identified on property diagram if pressure and temperature of the steam are known.	**Because**	Both pressure and temperature are regarded as intensive properties of thermodynamic system.
3. A room with perfect insulation will experience only a slow drop in room temperature if a refrigerator with its door open is kept inside this room with continued electric supply to the refrigerator.	**Because**	The heat generated due to friction in the working parts of the running compressor of the refrigerator is dissipated to its surrounding.
4. First Law of Thermodynamics does not distinguish between heat and work and establishes equivalence between two forms of energy.	**Because**	Equal quantities of heat and work have the same worth and conversions from one form to another occur without any loss in availability in each case.
5. Carnot engine is a hypothetical device and it is not possible to construct practical engine with two adiabats and two isotherms.	**Because**	The two adiabats cannot have a common point so also two isotherms.
6. In the conventional nuclear power plant nuclear fission of the fissionable material produces large amount of heat.	**Because**	In accordance with Einstein's relation some mass of the nuclear fuel converts into KE; High Kinetic Energy sub atomic particles penetrate into fuel element & thermal energy is manifested.

(II) In each of the following questions 4 or 5 possible options are given. Out of these possible answers/options only one is the best answer. Select the one (A or B or C, -- etc) and write the alphabet (' ') as the answer. **3**

(All exercises carry equal marks).

1. In a domestic refrigerator working on vapor compression refrigeration, the condition of refrigerant entering the evaporator usually is-
   - **A.** High pressure wet vapor
   - **B.** Low pressure, mostly liquid
   - **C.** Superheated vapor
   - **D.** Saturated vapor

2. If internal energy of fluid occupying 1 m^3 at pressure of 0·33 MPa is 3 MJ, its enthalpy is-
   - **A.** 9000 kJ
   - **B.** 9900 kJ
   - **C.** 3330 kJ
   - **D.** 3000 kJ

3. The Stefan-Boltzmann Law is applicable for heat propagation by means of
   - **A.** Conduction and radiation combined
   - **B.** Convection and radiation combined
   - **C.** Convection alone
   - **D.** Radiation alone
   - **E.** All modes of heat transmission.
