Registration No: | | | | | | | | | | |

Total Number of Pages: 04 **B.TECH**
15BE2103

2nd Semester Back Examination 2016-17
THERMODYNAMICS
BRANCH(S): ALL
Time: 3 Hours
Max Marks: 100
Q.CODE: Z930

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Answer the following questions with correct option: (2 x 10)

a) As the temperature increases, the thermal conductivity of a gas
(A) increases
(B) decreases
(C) remains constant
(D) increases up to a certain temperature and then decreases

b) A bimetal plate consists of two materials of different coefficients of thermal expansion. The coefficient of thermal expansion of the top part of the plate is less than the bottom part. If the temperature of the entire plate increases, what happens to the plate?
(A) Expends
(B) Contracts
(C) Stays the same
(D) Bends down
(E) Bends up

c) Which of the following temperature scales doesn't have negative numbers?
(A) Celsius
(B) Kelvin
(C) Reaumur
(D) Fahrenheit
(E) Galileo

d) The temperature of an ideal gas increases from 20℃ to 40℃ while the pressure stays the same. What happens to the volume of the gas?
(A) It doubles
(B) It quadruples
(C) It is cut to one-half
(D) It is cut to one-fourth
(E) it slightly increases

e) Internal energy of an ideal gas depends on:
i. the volume of the ideal gas
ii. the pressure of the ideal gas
iii. the absolute temperature of the ideal gas

(A) I (B) II (C) III (D) I and II (E) I, II and III

f) An ideal gas with an internal energy U initially at 0℃ is heated to 273℃. What is the new internal energy in terms of U?
(A) U (B) 1/2U (C) 1/4U (D) 2U (E) 4U

g) An ideal heat engine operates between two temperatures 600 K and 900 K. What is the efficiency of the engine?
(A) 50% (B) 80% (C) 100% (D) 10% (E) 33%

h) Which of the following is a characteristic of an adiabatic process?
(A) $\Delta U = 0$
(B) $W = 0$
(C) $Q = 0$
(D) $\Delta V = 0$
(E) $\Delta P = 0$

i) If the absolute temperature of a radiating object is doubled, by what factor does the rate of energy emission change?
(A) 2 (B) 4 (C) 8 (D) 16 (E)32

j) Which mechanism of heat transfer is involved in heating a pot with water on a stove?
(A) Convection
(B) Conduction
(C) Radiation
(D) Induction
(E) None of the above

Q2 Answer the following questions: (2 x 10)

a) What is the difference between the classical and the statistical approaches to thermodynamics?

b) What is the difference between intensive and extensive properties? Explain with examples.

c) What is a quasi-equilibrium process? What is its importance in engineering?

d) What is the difference between gage pressure and absolute pressure? Vacuum gage connected to a chamber reads 35 kPa at a location where the atmospheric pressure is 92 kPa. Determine the absolute pressure in the chamber.

e) Is iced water a pure substance? Why?
What is the difference between saturated liquid and compressed liquid?

f) A piston–cylinder device initially contains 0.07 m3 of nitrogen gas at 130 kPa and 120°C. The nitrogen is now expanded polytropically to a state of 100 kPa and 100°C. Determine the boundary work done during this process.

g) Prove that the amount of heat transferred to the system at constant pressure process is equal to the change in enthalpy.

h) What do you mean by thermal equilibrium?

i) A steam power plant with a power output of 150 MW consumes coal at a rate of 60 tons/h. If the heating value of the coal is 30,000 kJ/kg, determine the overall efficiency of this plant.

j) What is the difference between a refrigerator and an air conditioner.
Define the coefficient of performance of a refrigerator in words. Can it be greater than unity?

Part – B (Answer any four questions)

Q3 **a)** The 60-W fan of a central heating system is to circulate air through the ducts. The analysis of the flow shows that the fan needs to raise the pressure of air by 50 Pa to maintain flow. The fan is located in a horizontal flow section whose diameter is 30 cm at both the inlet and the outlet. Determine the highest possible average flow velocity in the duct. **(10)**

b) Consider a U-tube whose arms are open to the atmosphere. Now water is poured into the U-tube from one arm, and light oil (r _ 790 kg/m3) from the other. One arm contains 70-cm-high water, while the other arm contains both fluids with an oil-to-water height ratio of 4. Determine the height of each fluid in that arm. **(5)**

Q4 **a)** An insulated piston–cylinder device contains 100 L of air at 400 kPa and 25°C. A paddle wheel within the cylinder is rotated until 15 kJ of work is done on the air while the pressure is held constant. Determine the final temperature of the air. Neglect the energy stored in the paddle wheel. **(10)**

b) The inner and outer surfaces of a 0.5 cm thick 2-m×2-m window glass in winter are 10°C and 3°C, respectively. If the thermal conductivity of the glass is 0.78 W/m · °C, determine the amount of heat loss, in kJ, through the glass over a period of 5 h. What would your answer be if the glass were 1 cm thick ? **(5)**

Q5 **a)** A 4-m×5-m×6-m room is to be heated by a baseboard resistance heater. It is desired that the resistance heater be able to raise the air temperature in the room from 7 to 23°C within 15 min. Assuming no heat losses from the room and an atmospheric pressure of 100 kPa, determine the required power of the resistance heater. Assume constant specific heats at room temperature. **(10)**

b) Show that for an ideal gas, C_p-C_v=R. **(5)**

Q6 **a)** Saturated steam coming off the turbine of a steam power plant at 30°C condenses on the outside of a 3-cm outer- diameter, 35-m-long tube at a rate of 45 kg/h. Determine the rate of heat transfer from the steam to the cooling water flowing through the pipe. **(10)**

b) Prove that entropy is a property of the system. **(5)**

Q7 **a)** A rigid, insulated tank that is initially evacuated is connected through a valve to a supply line that carries steam at 1 MPa and 300°C. Now the valve is opened, and steam is allowed to flow slowly into the tank until the pressure reaches 1 MPa, at which point the valve is closed. Determine the final temperature of the steam in the tank. **(10)**

b) Determine the COP of a heat pump that supplies energy to a house at a rate of 8000 kJ/h for each kW of electric power it draws. Also, determine the rate of energy absorption from the outdoor air. **(5)**

Q8 **a)** A Carnot engine (CE-1) works between two temperature reservoirs *A* and *B*, where T_A = 900 K and T_B = 500 K. A second Carnot engine (CE-2) works between temperature reservoirs *B* and *C*, where T_C = 300 K. In each cycle of CE-1 and CE-2, all the heat rejected by CE-1 to reservoir *B* is used by CE-2. For one cycle of operation, if the net *Q* absorbed by CE-1 from reservoir *A* is 150 MJ, then find out the net heat rejected to reservoir *C* by CE-2 (in MJ). **(10)**

b) What is the difference between SI and CI engine? Explain with proper diagram. **(5)**

Q9 **a)** Derive the Steady Flow Energy equation [SFEE] for turbine from the Energy balance equation. **(10)**

b) Draw the layout of a steam power plant with its basic components. **(5)**