Con. 6448–13. **GS–6165**

(3 Hours) **[Total Marks : 100**

N.B. : (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions from remaining **six** questions.
(3) Draw neat sketches to illustrate your answers.
(4) **Figures** to **right** indicate **full** marks.

1. Solve any five of the following: **20**
(a) State and explain the first law for a closed system.
(b) Draw a simple schematic diagram of a thermal power plant with one reheater. Also represent this on T-S diagram.
(c) Show that entropy is a property of a system.
(d) Define i) Availability Ii) unavailability iii) dead state iv) irreversibility
(e) Sketch the Rankine cycle on P-V and T-S diagram.
(f) Define dryness fraction, saturation temperature work ratio, specific steam consumption.

2. (a) State and explain the equivalence of Kelvin plank statement and Claussius statement of second law of thermodynamics. **08**

(b) 300 kJ/s of heat is supplied at a constant fixed temperature of 290°C to a heat engine. The heat rejection takes place at 8.5°C. The following results were obtained:
(a) 215 kJ/s are rejected
(b) 150 kJ/s are rejected
(c) 75 kJ/s are rejected
Classify which of the result report a reversible cycle or irreversible cycle or impossible results. **12**

3. (a) What is the effect of reheat on i) specific output ii) cycle efficiency iii) steam rate iv) Heat rate of steam power plant. **08**

(b) A system receives 50 kJ of heat while expanding with volume change of $0.14m^3$ against an atmosphere of $1.2 X10^5 N/m^2$. A mass of 90 kg in the surroundings is also lifted through a distance of 5.5 meters.
(a) Find the change in the energy of the system.
(b) The system is returned to its initial volume by an adiabatic process which requires 110 kJ of work. Find the change in the energy of the system.
For the combined process of (a) and (b) determine the change in energy of the system. **12**

4. (a) Define C.O.P of Heat Pump and Refrigerator and derive the relationship between the two. **04**

(b) 4 kg of air is compressed from 40°C and 125 kPa to 250°C and 875 kPa. It is then throttled to 257 kPa. Finally, it is cooled to a pressure of 125 kPa and 180°C. Calculate the overall change in entropy and also for each process. Take C_p=1.005 kJ/kg K and C_v=0.717 kJ/kg K. **10**

(c) State the principle of increase of entropy of the universe and discuss anyone application. 06

5. (a) Derive an expression for efficiency of diesel cycle. 10

(b) An I.C. engine operating on the dual cycle (limited pressure cycle) the temperature of the working fluid (air) at the beginning of the compression is 27°C. The ratio of the maximum and the minimum pressures of the cycle is 70 and compression ratio is 15. The amounts of heat added at constant volume and constant pressure are equal. Compute the air standard thermal efficiency of the cycle. State the three main reasons why the actual thermal efficiency is different from the theoretical value. Take γ for air =1.4. 10

6. (a) Define dryness fraction, critical point, triple point and degree of superheat. 06
(b) Calculate the volume, density, enthalpy and entropy of 2 kg of steam at 80° C and dryness fraction of 0.85. 08

(c) Describe the phase change process of water using T-V diagram. 06

7. (a) Derive with usual notations the relation for one dimensional isentropic flow of gas
$dA/A=dV/V*(1-M^2)$
Explain the significance of the above relationship. 10

(b) Discuss the Fanno and Rayleigh line on h-s diagram as a solution to normal shock equation. 05

(c) Explain how normal and shock wave is developed. 05