Mid-Semester Examination
Thermodynamics (PHY313)
Full Marks: 50, Time: 2 hours

1. Is the fundamental relation $S = \left(\frac{R^3}{v_0\theta^2}\right)^{\frac{1}{5}} [N^2 V\, U^2]^{\frac{1}{5}}$ a valid one? **(Justify your answer with necessary calculations.)** **(5)**

2. Find the three equations of state in the entropy representation for a system with the fundamental equation $u = \frac{v_0^{\frac{1}{2}}\theta}{R^{3/2}} \frac{s^{\frac{5}{2}}}{v^{\frac{1}{2}}}$, where v_0, θ and R are constants. **(10)**

3. Two particular systems have the following equations of state, $\frac{1}{T^{(1)}} = \frac{3}{2} R \frac{N^{(1)}}{U^{(1)}}$ and $\frac{1}{T^{(2)}} = \frac{5}{2} R \frac{N^{(2)}}{U^{(2)}}$ where R is the gas constant. The mole number of the first system is $N^{(1)} = 2$ and that of the second system is $N^{(2)} = 3$. The two systems are separated by a diathermal wall and the total energy of the composite system is 2.5×10^3 J. What is the internal energy of each system in equilibrium? **(10)**

4. One mole of ideal gas at $0^\circ C$ temperature is heated at constant pressure till its volume is twice its initial value. Calculate the amount of heat absorbed. [$C_V = 20.9$ J mol^{-1} K^{-1} and $R = 8.3$ J mol^{-1} K^{-1}] **(5)**

5. It is informed that an engine working on Carnot cycle between temperatures $1400^\circ C$ and $30^\circ C$ receives 4.2 kJ s^{-1} of heat and generates a power 3.675 kW. Discuss if this power generation is feasible. **(Show all supporting calculations.)** **(10)**

6. 10 kg of water at 273 K is brought in contact with a heat reservoir at temperature 373 K. If water attains the temperature of the reservoir, find the change in entropy of (i) water (ii) reservoir and (iii) the universe. Take the specific heat capacity of water $= 4.18\ 10^3$ J kg^{-1} K^{-1}. **(10)**