Assignment 4
(Not to be submitted – only for practice)

1. A steady-flow Carnot refrigeration cycle uses refrigerant-134a as the working fluid. The refrigerant changes from saturated vapour to saturated liquid at 30°C in the condenser as it rejects heat. The evaporator pressure is 160 kPa. Show the cycle on a *T-s* diagram relative to saturation lines, and determine (*a*) the coefficient of performance, (*b*) the amount of heat absorbed from the refrigerated space, and (*c*) the net work input.
2. A refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapour-compression refrigeration cycle between 0.12 and 0.7 MPa. The mass flow rate of the refrigerant is 0.05 kg/s. Show the cycle on a *T-s* diagram with respect to saturation lines. Determine (*a*) the rate of heat removal from the refrigerated space and the power input to the compressor, (*b*) the rate of heat rejection to the environment, and (*c*) the coefficient of performance.
3. A refrigerator uses refrigerant-134a as the working fluid and operates on the ideal vapour-compression refrigeration cycle. The refrigerant enters the evaporator at 120 kPa with a quality of 30 percent and leaves the compressor at 60°C. If the compressor consumes 450 W of power, determine (*a*) the mass flow rate of the refrigerant, (*b*) the condenser pressure, and (*c*) the COP of the refrigerator.
4. A heat pump with refrigerant-134a as the working fluid is used to keep a space at 25°C by absorbing heat from geothermal water that enters the evaporator at 50°C at a rate of 0.065 kg/s and leaves at 40°C. The refrigerant enters the evaporator at 20°C with a quality of 23 percent and leaves at the inlet pressure as saturated vapour. The refrigerant loses 300 W of heat to the surroundings as it flows through the compressor and the refrigerant leaves the compressor at 1.4 MPa at the same entropy as the inlet. Determine (*a*) the degrees of subcooling of the refrigerant in the condenser, (*b*) the mass flow rate of the refrigerant, (*c*) the heating load and the COP of the heat pump, and (*d*) the theoretical minimum power input to the compressor for the same heating load.
5. Consider a two-stage cascade refrigeration system operating between the pressure limits of 0.8 and 0.14 MPa. Each stage operates on the ideal vapour-compression refrigeration cycle with refrigerant-134a as the working fluid. Heat rejection from the lower cycle to the upper cycle takes place in an adiabatic counter flow heat exchanger where both streams enter at about 0.4 MPa. If the mass flow rate of the refrigerant through the upper cycle is 0.24 kg/s, determine *a*) the mass flow rate of the refrigerant through the lower cycle, (*b*) the rate of heat removal from the refrigerated space and the power input to the compressor, and (*c*) the coefficient of performance of this cascade refrigerator.
6. A gas refrigeration system using air as the working fluid has a pressure ratio of 5. Air enters the compressor at 0°C. The high-pressure air is cooled to 35°C by rejecting heat to the surroundings. The refrigerant leaves the turbine at -80°C and then it absorbs heat from the refrigerated space before entering the regenerator. The mass flow rate of air is 0.4 kg/s. Assuming isentropic efficiencies of 80 percent for the compressor and 85 percent for the turbine and using constant specific heats at room temperature, determine (*a*) the effectiveness of the regenerator, (*b*) the rate of heat removal from the refrigerated space, and (*c*) the COP of the cycle. Also, determine (*d*) the refrigeration load and the COP if this system operated on the simple gas refrigeration cycle. Use the A same compressor inlet temperature as given, the same turbine inlet temperature as calculated, and the same compressor and turbine efficiencies.
7. Air at a condition of 30^0C dry bulb, 17^0C wet bulb and a barometer pressure of 1050 m bar enters an equipment where it undergoes a process of adiabatic saturation, the air leaving with a moisture content of 5g/kg higher than what it was while entering. Calculate;
   a) Moisture content of air entering the equipment.
   b) Dry bulb temperature and enthalpy of the air leaving the equipment.
8. a) The temperature of air entering an adiabatic saturator is 42^0C and the leaving air temperature is 30^0C. Compute the humidity ratio and relative humidity of entering air.
   b) The conditions inside a room are 25^0C and 50% degree of saturation. The inside surface temperature of the glass window is 10^0C. Will the moisture condense from room air upon the window glass.
9. Moist air at standard atmospheric pressure is passed over a cooling coil. The inlet and exit states are as follows;

Number	State	DBT ^{0}C	RH %
1	Inlet	30	50
2	Exit	15	80

Show the process on a psychometric chart. Determine the amount of heat and moisture removed per kg of dry air.

10. Air at 20^0C DBT and 19^0C DPT enters a heating and humidifying apparatus, from which it leaves at 35^0C DBT and 28^0DPT. Moisture is supplied as liquid water at 25^0C to humidify the air. Find the quantity of heat that must be added per kg of dry air through the apparatus.
11. 39.6 cmm of a mixture of recirculated room air and outdoor air enter a cooling coil at 31^0C DB and 18.5^0C WB temperatures. The effective surface temperature of the coil is 4.4^0C. The surface area of the coil is such as would give 12.5 KW of refrigeration with the given entering air state. Determine the dry and wet bulb temperatures of the air leaving the coil and coil bypass factor.