Assignment and Short type questions
Module 6: Humidification and Air Conditioning

Assignment Problems:
Assignment Problem 6.1: Determine the following psychrometric properties of a moist air sample having a dry-bulb temperature 27°C and a humidity of 0.015 kg/kg dry air, using the psychrometric chart and/or the vapor pressure equation for water: (a) Relative humidity (b) Dew point (c) Adiabatic saturation temperature (d) Wet-bulb temperature (e) Enthalpy (f) Humid volume (g) Humid heat. Antoine Equation: \( \ln P_A^V \text{(bar)} = 11.96481 - 3984.923/(T-39.724) \). Total pressure is 1 atm.

Ans: (a) 66.8%; (b) 20.3°C; (c) 22.5°C; (d) 22.5°C; (e) 64.7, 65.6, 64 kJ/kg dry air; (f) 0.87, 0.88, 0.873 m³/kg dry air; (g) 1.033 kJ/kg dry air. °C

Assignment Problem 6.2: A sample of air has a dry-bulb temperature of 33°C and wet-bulb temperature of 23°C. The total pressure is atmospheric. (a) Determine the following psychrometric properties – humidity; enthalpy; dew point; humid volume and humid heat. (b) If the sample air is heated to 50°C, what will be its wet-bulb temperature? (c) How much heat is rejected if 1 kg of air (dry basis) is cooled down from 33°C to 15°C? (d) If the air sample is heated to 50°C and its pressure is doubled (2 atm.), what would be its relative humidity and dew point? Antoine Equation: \( \ln P_A^V \text{(bar)} = 11.96481 - 3984.923/(T-39.724) \).

Ans: (a) Humidity, \( Y = 0.014 \) kg/kg dry air; Enthalpy, \( H = 69.03 \) KJ/kg dry air; Dew point, \( T_d = 19.95 \) C; Humid volume, \( v_f = 0.0886 \) m³/kg dry air; Humid heat, \( c_f = 1.031 \) KJ/(kg dry air). C; (b) \( T_{wb} = 27°C \); (c) \( \Delta H = 28.558 \) KJ/kg dry air; (d) R.H. = 37.77% and \( T_d = 31°C \)
Assignment Problem 6.3: Determine the adiabatic saturation temperature and wet-bulb temperature of air-ethanol system. The temperature of air is 30°C and it does not contain any ethanol.

Given: Diffusivity of ethanol in air, $D_{AB}=0.145 \text{ cm}^2/\text{s}$ at 313K and 1 atm; the vapor pressure equation of ethanol is $\ln P_V=12.05896-3667.705/(T-46.966)$, $T$ in K, take other properties of air from literature.

Ans: 276.2K, 275.2K

Short type questions:
1. (a) What are wet bulb temperature and adiabatic saturation temperature? (b) Classify cooling tower based on air draft and air flow pattern. (c) What is the role of louvers in cooling tower?
   Ans: (c) Entry of air is regulated by louver. It minimizes the water loss by drift.
2. The % humidity is less than the relative humidity only at ........percent humidity. (a) 0 (b) 100 (c) both a & b (d) none of these.
3. Wet bulb and dry bulb temperature becomes identical at ........ percent saturation curve. (a) 100 (b) 50 (c) 0 (d) none of these.
4. The falling rate period in a drying of a solid is characterized by (a) increase in rate of drying (b) increasing temperatures both on the surface and within the solid (c) decreasing temperature (d) none of these.
5. The temperature of cooled water in a cooling tower is (a) always less than the wet-bulb temperature of entering air, (b) always greater than the wet-bulb temperature of entering air, (c) always equal to the wet-bulb temperature of entering air, (d) always equal to the dry-bulb temperature of entering air.
6. Merkel Equation is related to (a) extraction, (b) humidification, (c) drying (d) none of these.
7. What is the maximum possible humidity (kg/kg dry air) of air at 30°C and at 1.3 atm pressure? (a) 0.05 (b) 0.0207 (c) 0.009 (d) 0.042.
   Ans: 2. c; 3. a; 4. b; 5. b; 6. b; 7. b
8 (a) What is the maximum possible humidity of air at $30^0\text{C}$ and 1.3 atm. pressure? (b) In case of cooling towers, what are “range” and “approach”?

**Ans:** (a) $Y=0.0207$ kg/kg dry air; (b) Range: cooling range ($T_{L2}-T_{L1}$); Approach: Approach to wet bulb temperature ($T_{L1}-T_{as}$) where $T_{L1}$ is liquid outlet temperature; $T_{L2}$ is liquid inlet temperature and $T_{as}$ is adiabatic saturation temperature.