| DEPARTMENT OF AERONAUTICAL AND AUTOMOBILE ENGINEERING<br>MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL | | |
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| **In Semester exam-SET 4** | | |
| Subject: Thermodynamics(AAE-2158) | Semester: III | Branch: Aero/Auto Engineering |
| Date: 17/12/2021 | **Duration: 80 minutes** | **Max. Marks: 20** |

**Note: Answer all questions. Finish Writing in 80 minutes. 10 Minutes for scanning and uploading.**

You can use-steam table, psychrometric chart, 1st and 2nd law of thermodynamics, relation between internal energy and enthalpy, temperature change, relation between current, voltage, time and power and all other relevant formulae

**All answers should be neatly presented with all relevant steps, units for the answers, diagrams wherever necessary. All answers should be properly highlighted to make it visible.**

**1.**A piston-cylinder contains 25 grams of saturated vapor of water at 200kPa pressure. An electric heating coil is inserted into the cylinder supplies current of 0.2 Amps for a duration of 5 minutes second at 120volt. Due to this electric heating, the piston moves out to maintain constant pressure. Since, the cylinder is conducting, heat of 3.7 kJ is dissipates out of cylinder during this process. Find the enthalpy of the system at the end of the process. [**4 Marks]**

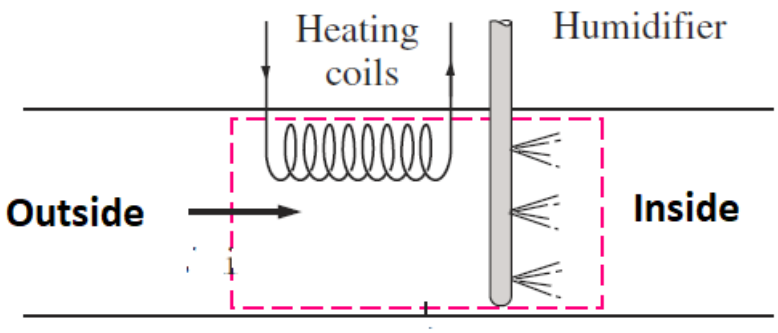
**2**.A refrigerator with COP 1.2 removes 1.2kW of heat from refrigerated place and transfers 2.2kW heat to the atmosphere. Is it justifiable as per first law of thermodynamics? If yes, prove it.

A refrigerator being run in kitchen. When refrigerator door was kept open for 3 minutes for stacking food items inside, total of 200kJ of heat enters into the refrigerator. If the COP of refrigerator is 1.5, determine the power requirement for running the refrigerator to remove this heat and keep the refrigerator cool. How much internal energy of the kitchen space raises? **[4 Marks]**

**3.** Is 0.2MPa and 250 degrees Celsius steam superheated? If yes, what is internal energy, specific volume and enthalpy of this steam?

Will its specific volume change if is cooled inside a rigid container? If cooling is done in a constant pressure condition (inside a piston-cylinder arrangement), at what temperature the given steam becomes just saturated vapor and just saturated liquid? If cooling is continued in constant pressure condition till the steam turns to be a wet steam of 30% wetness, what will be its internal energy, specific volume and enthalpy? **[3 Marks]**

**4.**An air-conditioning(AC) system is used increase the temperature and relative humidity(RH) of air which is at 10 degrees Celsius and 30% RH to 25 degrees and 60% RH first by heating till 22 degrees Celsius through a heating coil then by spraying hot steam while it passes through the AC system (refer figure below). Represent these processes in psychrometric chart. If $50m^3$/min of air is entering the AC, what is the capacity of heating coil (in Watt or kWatt)? What is the humidifier capacity(kg/min) so that final condition of air is reached? **[3 Marks]**




**5**.A nozzle is fixed at the end of a pipe to supply some fluid at high velocity. Pipe is of cross-sectional area $0.1m^2$ and carrying the fluid at 60m/s velocity, enthalpy of 3120kJ/Kg and specific volume of 0.187 $m^3$/Kg. if the enthalpy of the fluid exiting from nozzle is 2882kJ/Kg, what will be the velocity at the end of nozzle exit? Also find mass flow rate of fluid through the nozzle. **[3 Marks]**

**6.**Write all possible air-conditioning processes in psychrometric chart.

**[3 Marks]**