BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
First Semester (2022-2023)
ME F217 Applied Thermodynamics
End-Semester Examination – Regular – Open Book

December 21, 2022
Max Marks = 70 **Duration: 180 min**

Instructions

- *There are 7 questions in this paper. Question paper is printed on both sides.*
- *Clearly underline the final answer. Answer the questions sequentially.*
- *Make suitable assumptions wherever necessary and clearly mention the same.*

Q1. The discharge of moist air from a clothes dryer is at 35°C and 80% RH. The flow os guided through a pipe up through the roof and a vent to the atmosphere. Due to the heat transfer in the pipe, the flow is cooled to 24°C by the time it reaches the vent. Evaluate the humidity ratio in the flow out of the clothes dryer and at the vent, the heat transfer and any amount of liquid that may be forming per kg of dry air for the flow. **[8 M]**

Q2. A gas obeying the equation of state P(v-a) = RT expands in the turbine from 800 kPa and 380 °C to 150 kPa and 50°C. Evaluate the specific work output of the turbine and the change in entropy. Given that the value of 'a' in the equation of state is 0.01 m^3/kg. Assume that the C_p varies as C_1+C_2T for the specified range of operating conditions. **[6 M]**

Q3. A diesel engine working on a Diesel cycle has a compression ratio of 14. The pressure at the beginning of the compression stroke is 1 bar and 27°C. The maximum temperature is 2500°C. Determine the cut off ratio, maximum pressure and thermal efficiency using constant specific heat approach. Compare (explain using the Ts and Pv diagram only) the thermal efficiency of an otto cycle having same maximum pressure and temperature. **[8 M]**

Q4. In a thermal power plant operating on an ideal Rankine cycle, superheated steam produced at 5 MPa and 500°C is fed to a turbine where it expands to the condenser pressure of 10 kPa. If the net power output of the plant is to be 20 MW, determine:

a. Heat added in the boiler per kg of water,
b. Thermal efficiency of the cycle
c. Mass flow rate of steam in kg/s
d. Mass flow rate of cooling water in the condenser if the cooling water enters the condenser at 25°C and leaves at 35°C. **[8 M]**

Q5. An air-conditioned school building has a sensible cooling load of 60 kW and a latent load of 40 kW. The indoor design conditions are 24°C (dry bulb temperature, DBT) and 50% (relative humidity, RH), while the outdoor conditions are 35°C (DBT) and 40% RH. To maintain adequate indoor air quality, outdoor air is mixed with re-circulated air in the ratio of 1:3 (by mass). Since the latent load on the building is high, a reheat coil is used downstream of the *cooling and dehumidifying* coil (CDC) having a bypass factor of 0.15. Air is supplied to the conditioned space at 14°C (DBT). **[14 M]**

Q6. A food storage locker requires a refrigeration system of 50 kW capacity at an evaporator temperature of -10°C and a condenser temperature of 35°C. The refrigerant used is ammonia which is subcooled by 5°C before entering the expansion valve and the vapor is dry saturated before leaving the evaporator. The two-cylinder compressor with stroke equal to 1.2 times the bore operates at 1000 rev/min. Determine:

a. The coefficient of performance
b. The mass of refrigerant to be circulated per minute,

c. The power required
d. The heat removed through condenser, and
e. The cylinder dimension by using the following equation:

Compressor displacement = $\frac{\Pi}{4} \times d^2 \times l \times N \times n$

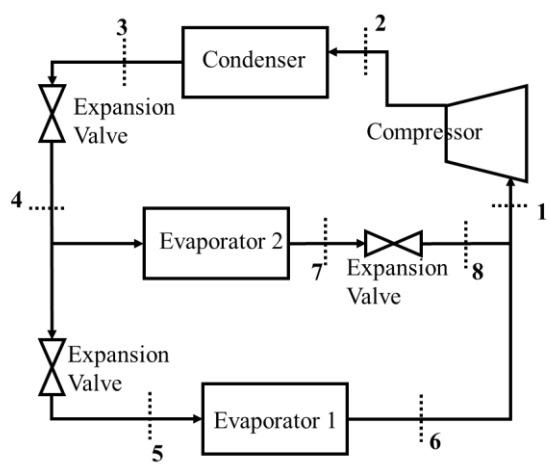
Where, d is the diameter, L is the stroke, N is rev/min and n is the number of cylinders. The volumetric efficiency of the compressor is 80%. **[14 M]**

Use the ammonia table below for calculation:

Saturation temperature, °C	Pressure, bar	Enthalpy, kJ/kg		Entropy, kJ/kg K		Specific volume, m^3/kg		Specific heat, kJ/kg K	
		Liquid	**Vapour**	**Liquid**	**Vapour**	**Liquid**	**Vapour**	**Liquid**	**Vapour**
- 10	2.91	154	1450	0.83	5.75	--	0.42	--	2.49
35	13.5	366	1489	1.56	5.21	1.7	0.096	4.56	2.90

Q7. The design of a vapor compression refrigeration unit with two evaporators using refrigerant 134a as the working fluid which is used for achieving refrigeration at two different temperatures with a single compressor and condenser. The 1ow temperature evaporator operates at -18 °C with saturated vapor at its exit and has a refrigerating capacity of 3 tons. The higher-temperature evaporator produces saturated vapor at 3.2 bar at its exit and has a refrigerating capacity of 2 tons. The compression process is isentropic to the condenser pressure of 10 bar and the refrigerant leaves the condenser as saturated liquid at 10 bar. Calculate

a. Mass flow rate of refrigerant through each evaporator in kg/s
b. The compressor power input in kW
c. The rate of heat transfer from the refrigerant passing through the condenser in kW **[12 M]**



***Best Wishes**