

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100

Duration: 3 Hours

Use of Refrigeration tables, Charts and Psychrometric chart is permitted.

PART A

Answer any three full questions, each carries 10 marks.

Marks

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| 1 | a) A simple saturated heat pump working with refrigerant 134a for space heating operates between temperature limits of 15°C and 50°C. The heat required to be pumped is 100MJ/hr. Calculate 1. Theoretical piston displacement of compressor 2. Theoretical power requirement 3. COP (7) | (7) |
| | b) With the help of necessary sketches prove that $COP_{\text{Heat Pump}} = COP_{\text{Refrigerator}} + 1$ (3) | (3) |
| 2 | a) An aircraft moving with speed of 1000 km/hr uses simple gas refrigeration system of 100TR capacity for air-conditioning. The ambient pressure and temperature are 0.35 bar and -10°C respectively. The pressure ratio of the compressor is 4.5. The heat exchanger effectiveness is 0.95. The isentropic efficiencies of compressor and expander are 0.8 each. The cabin pressure and temperature are 1.06 bar and 25°C. Determine i) temperatures and pressures at all points of the cycle and calculate (ii) COP, (iii) Power required (7) | (7) |
| | b) Describe working of a simple air conditioning system used for aircrafts (3) | (3) |
| 3 | a) Differentiate between wet and dry compression (3) | (3) |
| | b) A Freon 12 vapour compression system operating at a condenser temperature of 40°C and evaporator temperature 0°C develops 15TR. Determine 1. Theoretical piston displacement 2. Heat rejected in system 3. Carnot COP and actual COP of cycle. (7) | (7) |
| 4 | a) An aircraft refrigeration system has to handle a cabin load of 25 tonnes. The atmospheric temperature is 16°C. The atmospheric air is compressed to a pressure of 0.96 bar and temperature of 29°C due to ram action. The air is then further compressed in a compressor to 4.8bar, cooled in a heat exchanger to 66°C expanded in a turbine to 1 bar pressure and supplied to cabin. The air leaves the cabin at a temperature of 26°C. The isentropic efficiencies of both compressors and turbine are 0.9. Calculate 1. Mass of air circulated per minute 2. COP. Take for air $C_p = 1.005 \text{ kJ/kg K}$ and $\gamma = 1.4$. (7) | (7) |
| | b) Derive COP of a Carnot refrigerator and point out the limitations of reversed Carnot cycle and establish the significance of cycle. (3) | (3) |

PART B

Answer any three full questions, each carries 10 marks.

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| 5 | Explain a three stage cascade refrigeration system with figure. Show the system on p-h diagram. (10) | (10) |
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- 6 Explain with the help of flow diagram and on p-h & T-S diagram multi compression refrigeration system with flash cooler and single evaporator. (10)
- 7 Explain with a neat diagram working of a domestic refrigerator (10)
- 8 With neat labeled sketch explain the working of flooded evaporator. State its application. (10)

PART C

Answer any four full questions, each carries 10 marks.

- 9 a) Derive *Borda-Carnot equation*. (4)
- b) Air at standard atmospheric pressure and temperature of 20°C flowing with a velocity of 12 m/s enters a sudden enlargement where the duct area doubles. What is the increase in static pressure of the air as it passes through the enlargement? (6)
- 10 a) Air at 10°C and 70% RH and 30°C and 80% RH are mixed in equal proportions by weight in an adiabatic chamber and is left for sufficient time to reach equilibrium. Find properties of mixed air (6)
- b) Define (i) ADP, (ii) CSHF, (iii) DPT and (iv) Humidity ratio (4)
- 11 Sensible and latent loads on a space are 50 kW and 10 kW respectively. Cold and dehumidified air at 10°C DBT and 90% RH is used to maintain the space condition at 24°C DBT. Find (i) RSHF (ii) space relative humidity and (iii) mass flow rate of supply air? (10)
- 12 Space cooling load is estimated as $Q_S = 50$ kW and $Q_L = 5$ kW. The space and out door conditions are 24°C DBT and 50% RH and 35°C DBT and 40% RH. Given $m_o : m_{rc} = 0.25$, $ADP = 8^\circ\text{C}$ Find (i) Bypass factor of cooling coil (ii) supply and out door air quantities, (iii) CSHF and (iv) cooling coil load ($m_o = \text{mass of outside air}$, $m_{rc} = \text{mass of re circulated air}$) (10)
- 13 a) What are the major assignments of the control system in an air conditioning plant? (3)
- b) Draw the elements of a basic control system for an air conditioning plant in a flow diagram (3)
- c) Name at least ten major control components in an air conditioning system (4)
- 14 A 60°, 30×30 cm branch take off leaves a 30×50 cm trunk duct. The size of the down stream section is also 30×50cm. The upstream flow rate is 1.5 m³/s and the branch flow rate is 0.5 m³/s. The upstream pressure is 500 Pa and the air temperature is 15°C. (i) What is the pressure following the straight through section, and (ii) What is the pressure in the branch line? (10)
