# Model Answer
# RAC
## 5th sem
## Mechanical Engineering

[3X2 = 6]

1(a) **Refrigeration** :- The procem of maintaining the temp$^r$ of a system below the ambient one.

(b) $COP = \frac{\text{Refrigerating}}{\text{work done}}$.

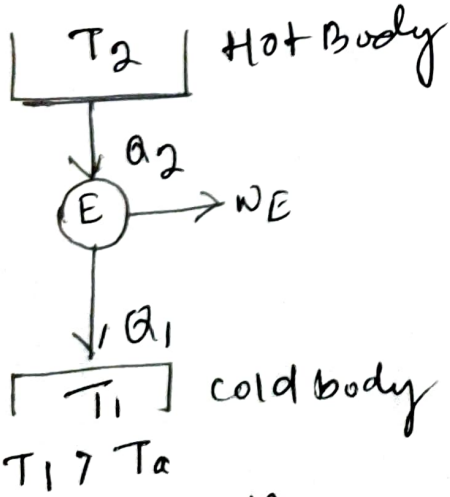
(c) Procem involve in Bell-coleman cycle :-
(a) Isentropic compremn
(b) Constant Prem$^r$ cooling
(c) Isentropic Expanmn
(d) Constant prem$^r$ ~~Heat~~ Heat additn

(d) 1 TR = 1000 X 335 Kj in 24 hrs.

$= \frac{1000 \times 335}{24 \times 60} = 232.6$ Kj/min

N.B. In actual practice 1 TR = 210 Kj/min or 3.5kw [2X3.5 = 7]

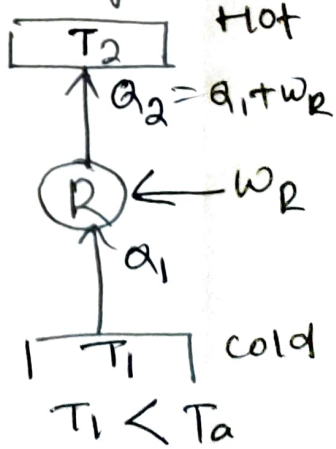
2(a) **Heat Engine**




$T_1 > T_a$

$\eta_E = COP_E = \frac{W_E}{Q_2} = \frac{Q_2 - Q_1}{Q_2}$

**Refrigerator**




$T_1 < T_a$

$COP_R = \frac{Q_1}{W_R} = \frac{Q_1}{Q_2 - Q_1}$

2(b) Advantages of VCRS over ARS :-

→ Smaller size for a given capacity.
→ Less running cost
→ Can be employed over a large range of Tempr.
→ COP is quite high.

2(c) OARS :-

→ The air is directly led to the space to be cooled;
→ The air is allowed to circulate through the cooler and then returned to the compressor to start another cycle.
→ Volume of air handled by compressor and expander is large.
→ It leads to the formation of frost at the end of exp^n process.

CARS :-

→ The air is passed through the pipes and component parts of the system at all times.
→ The air is used for absorbing heat from the other fluid (brine) and is cooled brine is circulated into the space to be cooled.
→ The air in this system does not come in contact directly with the space to be cooled.

[7×1=7]

3(a) $Q = 200\ TR$, $T_1 = -6°C = 267K$ $T_2 = 25°C = 298K$
$t_w = 25°C$ $h_{fg(ice)} = 335\ kJ/kg$

Mass of ice produced per day

Heat extracting capacity of Refrigerator $= 200 \times 210 = 42000\ kJ/min$

Heat removed from 1kg of water at 25°C to form ice at 0°C
$= m \times$ Sp. heat $\times$ Rise in Temp $+ h_{fg\ ice}$
$= 1 \times 4.187 (25-0) + 335 = 439.7\ kJ/kg$

Mass of ice produced per minute $= \frac{42000}{439.7} = 95.52\ kg/min$

Mass of ice produced per day $= 95.52 \times 60 \times 24$
$= 137550\ kg = 137.55\ tonnes$

Power required to drive the unit

$$COP = \frac{T_1}{T_2 - T_1} = \frac{267}{298 - 267} = 8.6$$

$$COP = \frac{\text{Heat extraction capacity}}{\text{work done per minute}}$$

$$\Rightarrow 8.6 = \frac{42000}{WD/min} \Rightarrow WD/min = \frac{42000}{8.6} = 4884 \text{ kg/min}$$

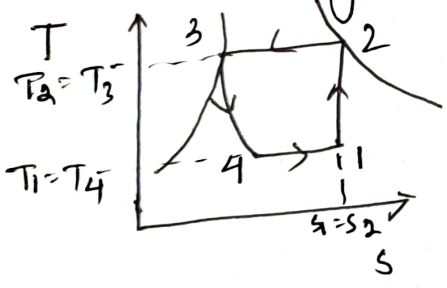
$$\therefore P = \frac{4884}{60} = \underline{81.4 kW} \quad (W_2)$$

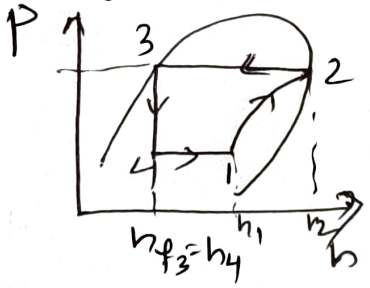
2(b) Ans:-

Data given:-

$P_1 = P_4 = 2$ bar, $x_1 = 0.85$ $x_4 = 0.19$, $w = 150$ kg/kg

$m_a = 4.5$ kg/min, $h_{fg} = 1325$ kJ/kg $V_g = 0.58$ m³/kg




(i) $h_4 = x_4 \times h_{fg} = 0.19 \times 1325 = 251.75$ kJ/kg

$h_1 = x_1 \times h_{fg} = 0.85 \times 1325 = 1126.25$ kJ/kg

$R_E = h_1 - h_4 = 1126.25 - 251.75 = 874.5$ kJ/kg

$w = 150$ kJ/kg

$$COP = \frac{R_E}{W} = \frac{874.5}{150} = \underline{5.83} \quad (W_2)$$

(ii) Volume of vapour entering in compressor per minute

= (Mass of refrigerant/min) × specific volume

$= m_a \times V_g = 4.5 \times 0.58$

$= \underline{2.61 \text{ m}^3/\text{min}}$ $W_2$