where $n = 1.135$ for dry saturated steam
P_1 = Pre. of steam at entry in N/m² absolute.
v_1 = vol. of one kg. of steam at pre. P_1 in m³
P_2 = Pre. of steam N/m² abs.
A = Area of crossection (m²) of nozzle at the throat.
v_2 = vol. of one kg. of steam at absolute pre. P_2.

Now there is only one value of the ratio $\left(\frac{P_2}{P_1}\right)$ to which the discharge of steam through the nozzle is maxm. The value $\left(\frac{P_2}{P_1}\right)$ is called critical pre. ratio. Therefor we differentiate only that portion which is inside the square backets & equate it is zero.

i.e. $\frac{2}{n}\left(\frac{P_2}{P_1}\right)^{2/n-1} - \frac{n+1}{n}\left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}-1} = 0$ or $\frac{2}{n}\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}} = \frac{n+1}{n}\left(\frac{P_2}{P_1}\right)^{1/n}$

$= \left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}-\frac{1}{n}} = \frac{n+1}{n} \times \frac{n}{2} = \frac{n+1}{2}$

$\Rightarrow \left(\frac{P_2}{P_1}\right)^{\frac{1-n}{n}} = \frac{n+1}{2} = \left(\frac{2}{n+1}\right)^{-1}$ or $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{-n}{1-n}}$

$\Rightarrow \left(\frac{P_2}{P_1}\right) = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}} \Rightarrow \frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$

on for dry saturated is 1.135 & critical pre. ratio is 0.518.

Qt 12
Ans It may be defined as the ratio of isentropic head drop in the moving blades to isentropic head drop of the reaction turbine.

Thus degree of Reaction (R) = $\frac{\text{Enthalpy drop in moving blades}}{\text{Enthalpy drop in stage}} = \frac{h_2-h_3}{h_1-h_3}$

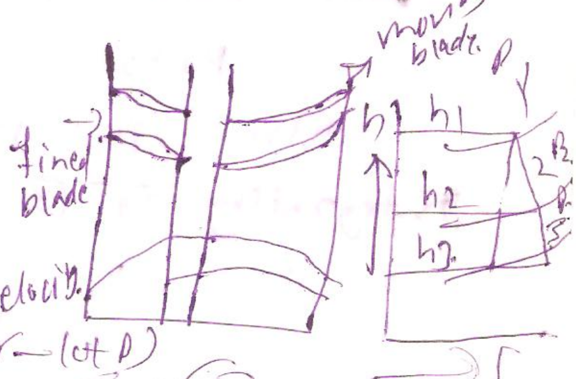
$= \frac{\text{Increase in the relative K.E in moving blade}}{\text{Stage work output}}$

$$\frac{V_{r0}^2 - V_{r1}^2}{V_b(V_{w1}-V_{w0})} = \frac{V_{r0}^2 - V_{r1}^2}{2V_b(V_{w1}-V_{w0})} \quad \text{—(1)}$$

$V_{r0} = V_f \operatorname{cosec}\gamma$ & $V_{r1} = V_f \operatorname{cosec}\beta$.

$V_{w1} + V_{w0} = V_f(\cot\beta + \cot\gamma)$

V_f = vel. of flow which remains constt. through the stage



$$\therefore R = \frac{V_f^2 \operatorname{cosec}^2\gamma - V_f^2 \operatorname{cosec}^2\beta}{2V_f(\cot\beta + \cot\gamma)V_b} = \frac{V_f(\cot\gamma - \cot\beta)}{2V_B} \quad \text{—(2)}$$

for 50% degree of reaction $V_b = V_f(\cot\gamma - \cot\beta)$ —(3)

from the vel. triangle V_b can also be expressed as under

$V_b = V_f(\cot\gamma - \cot\theta) = V_f(\cot\alpha - \cot\beta)$ —(4)

we get $\beta = \theta$, $\alpha = \gamma$ from ①, ③ & ④

Thus for a 50% reaction the moving & fixed blades must have the same shape. This condition gives the symmetrical velocity dia. this type of turbine is also known as Parson Reaction Turbine

when degree of reaction is $R = 0$ we have simple Impulse Turbine
" " " " is $R = 1$ " " Pure Reaction "

Q-13

Ans- (1) The air leakage in a condenser result in increasing the back pre. on the prime moves which means there is loss of heat drop & consequently thermal efficiency of the plant is lowered.

(2) The presence of Air in the condenser lowes the saturation temp. steam which means a lower saturation temp. as the saturation temp. of steam decreases, its latent heat increase so it will require greater amount of cooling tower.

(3) Because of poor thermal conductivity of air the rate of heat Transfer the vapour is reduced and the surface Area of the tubes has to be increased for a given condense duty.

Q-15.

Ans Two stage compressor with perfect intercooling

8147 = low pre. cycle

7236 = high pre. cycle.

for this Arrangment

$$w = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_4}{P_1}\right)^{\frac{n-1}{n}} - 1\right] + \frac{n}{n-1} P_2 V_2 \left[\left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 1\right] \quad ①$$

delivery temp. is given by

$$T_3 = T_2 \left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} = T_1 \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}} \quad \text{since } T_2 = T_1$$

Now since $T_2 = T_1$ then

$$P_2 V_2 = P_1 V_1$$

also $P_4 = P_2$

Integrating eqn ③ & ④ in eqn ①

$$w = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} + \left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 2\right]$$