CLASS TEST

S.No.: 01SKME_ABCDEFGHI_290925

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POWER PLANT

MECHANICAL ENGINEERING

Date of Test : 29/09/2025

ANSWER KEY

1.	(b)	7.	(d)	13.	(a)	19.	(b)	25.	(b)
2.	(b)	8.	(b)	14.	(b)	20.	(a)	26.	(d)
3.	(d)	9.	(b)	15.	(b)	21.	(b)	27.	(c)
4.	(b)	10.	(a)	16.	(d)	22.	(b)	28.	(a)
5.	(c)	11.	(a)	17.	(d)	23.	(a)	29.	(d)
6.	(c)	12.	(b)	18.	(c)	24.	(a)	30.	(b)

DETAILED EXPLANATIONS

1. **(b)**

$$\text{Slip factor, } \phi_s = \frac{V_{w2}}{u_2}$$

$$V_{w2} = \phi_s \cdot u_2$$

$$V_{w2} = 0.90 \times 370 = 333 \text{ m/s}$$

Absolute velocity at the exit of impeller

$$V_2 = \sqrt{V_{w2} + V_{f_2}^2} = \sqrt{333^2 + 35^2}$$

$$V_2 = 334.83 \text{ m/s}$$

$$\text{mass flow rate} = \rho_2 A_2 V_{f2}$$

$$= 1.57 \times 0.18 \times 35$$

$$= 9.89 \text{ kg/s}$$

2. **(b)**

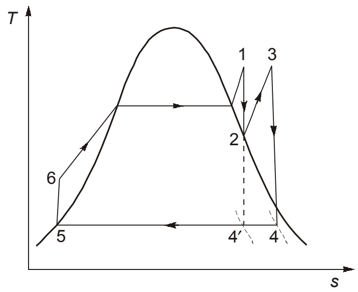
$$\text{Thermal efficiency} = \frac{W_{net}}{\dot{m}_f \times c.v} = \frac{80}{\left(\frac{1}{90}\right) \times 44 \times 10^3} = 16.36\%$$

3. **(d)**

In open cycle gas turbines cooling system is not required as more amount air can be used which will cool the turbine, but this is not true will closed cycle turbines.

4. **(b)**

Here, 1 - 2 - 4′ - 5 - 6 : Cycle without reheating and , 1 - 2 - 3 - 4 - 5 - 6 : Cycle with reheating

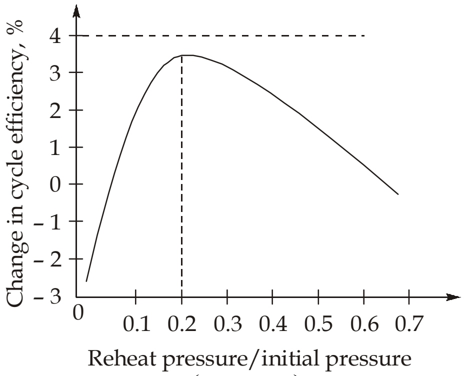


As can be seen from T-s diagram,

$$x_4 > x_{4'}$$

- By reheating, efficiency may increase or decrease.

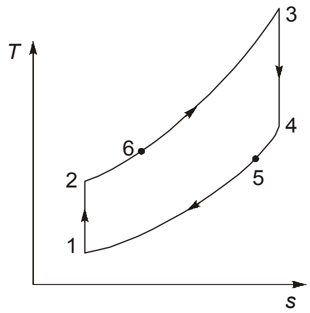
5. **(c)**



$$\left(\frac{P_{reheater}}{P_{boiler}}\right)$$

6. **(c)**

Given: T_4 = 1000 K, T_2 = 400 K



$$\text{Effectiveness of regenerator} = \frac{T_6 - T_2}{T_4 - T_2} = 0.7$$

$$\Rightarrow \quad \frac{T_6 - 400}{1000 - 400} = 0.7$$

$$\Rightarrow \quad T_6 = 820 \text{ K}$$

7. **(d)**

- Using some part of steam generated from the turbine for heating of feed water is known as regeneration. The regenerative features effectively raise cycle heat input temperature thereby reducing the amount of heat addition from the boiler/fuel source.
- By the use of higher boiler pressure, the mean temperature of heat addition is raised which result in increased efficiency.
- But in case of reheating of steam at intermediate stage, efficiency of Rankine cycle can increased or decreased. So, care must be taken so that while reheating steam at an intermediate stage, it raises the mean temperature of heat addition, thereby increasing the efficiency.

  So, the most suitable option is (d).

8. **(b)**

For Brayton cycle:

$$\eta_{optimum} = 1 - \sqrt{\frac{T_{min}}{T_{max}}} = 1 - \sqrt{\frac{300}{1200}} = 50\%$$

$$W_{max} = C_P\left[\sqrt{T_{max}} - \sqrt{T_{min}}\right]^2 = 1.005\left[\sqrt{1200} - \sqrt{300}\right]^2 = 301.5 \text{ kJ/kg}$$

9. **(b)**

$$W_{net} = W_T - W_C$$
$$= 160 \text{ kJ/kg}$$

and $$\frac{W_C}{W_T} = 0.35$$

$$W_T - 0.35W_T = 160$$

$$W_T = \frac{160}{0.65} = 246.15 \text{ kJ/kg}$$

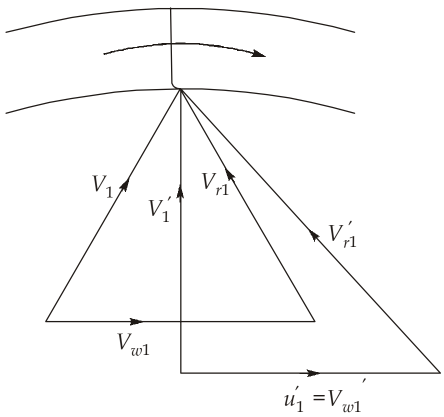
So, $$W_C = 0.35\,(246.15) = 86.15 \text{ kJ/kg}$$

Now, $$(W_{net})_{actual} = \eta_T W_T - \frac{W_C}{\eta_c}$$

$$= 0.75(246.15) - \frac{86.15}{0.75} = 69.74 \text{ kJ/kg}$$

10. (a)

Relative velocity at the inlet decreases, which in turn, decreases the Mach number. So, the possibility of shock wave at the inlet decreases.



Since the whirl component at the inlet decreases, power input and the pressure developed also decreases.

11. (a)

From definition of fanno line

$$h + \frac{V^2}{2} = \text{constant}$$

$$dh + VdV = 0$$

Steady flow (conservation of mass)

$$\rho V = \text{constant}$$

$$\rho dV + Vd\rho = 0$$

$$dV = -V\frac{d\rho}{\rho}$$

$$dh - V^2\frac{d\rho}{\rho} = 0 \quad \text{...(i)}$$

At the point of maximum entropy

$$ds = 0$$

$$T\cdot ds = dh - v\cdot dP$$

$$dh = \frac{dP}{\rho} \quad \text{...(ii)}$$

from equation (i) and (ii)

$$\frac{dP}{\rho} - V^2 \frac{d\rho}{\rho} = 0$$

$$\Rightarrow \quad V = \left(\frac{\partial P}{\partial \rho}\right)_s^{1/2}$$

12. (b)

$$\frac{P_2}{P_1} = 6, \qquad P_1 = 101.325 \text{ kPa}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma} = 6^{0.4/1.4} = 6^{0.286} = 1.6685$$

$$T_2 = 300 \times 1.6685 = 500.55 \text{ K}$$

$$\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{(\gamma-1)/\gamma} = 6^{0.4/1.4} = 1.6685 = \frac{T_2}{T_1}$$

$$W_T = 2.5\, W_C$$

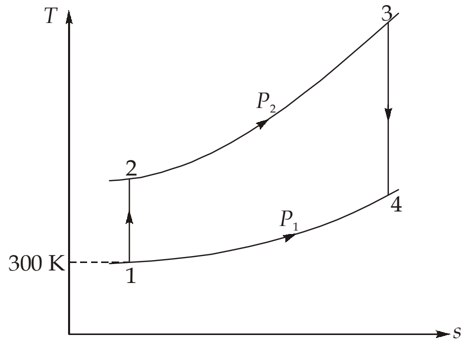
$$c_p(T_3 - T_4) = 2.5(T_2 - T_1)\, c_p$$

$$T_3 - T_4 = 2.5(T_2 - T_1)$$

$$T_3 - \frac{T_3}{1.6685} = 2.5 \times (500.55 - 300)$$

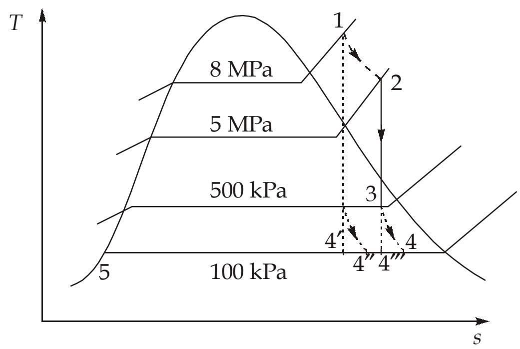
$$T_3\left(1 - \frac{1}{1.6685}\right) = 501.375$$

$$T_3 = \frac{501.375}{0.40066} = 1251.4 \text{ K} = 978.4°\text{C}$$



13. (a)

Here, on T-s diagram the process is drawn by 1 - 2 - 3 - 4,



On removal of valve, steam at state 1 will expand directly to 4′ hence the quality of steam at exit will decreases,

Also, $\quad h_4' = h_f + x h_{fg}$

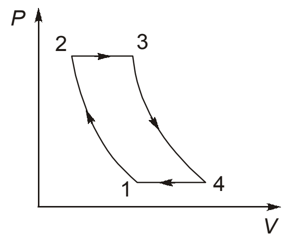
So, $\quad x\downarrow = h_4'$ will also decrease,

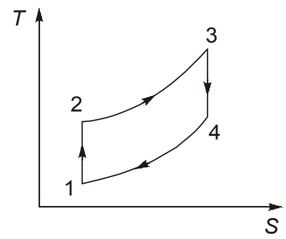
Hence, the removal of valves will increase the turbine work. $[W_T = h_1 - h_4']$

14. (b)

Given,

$P_1 = 1$ bar
$P_2 = 6$ bar
$T_2 = 500$ K
$T_4 = 900$ K
$\gamma = 1.4$
$T_3 = ?$
$T_1 = ?$





For isentropic process 1 – 2

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$\Rightarrow \quad \frac{500}{T_1} = (6)^{\frac{0.4}{1.4}}$$

$$\Rightarrow \quad T_1 = 299.66 \text{ K} \approx 300 \text{ K}$$

For isentropic process 3 – 4

$$\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{\frac{\gamma-1}{\gamma}}$$

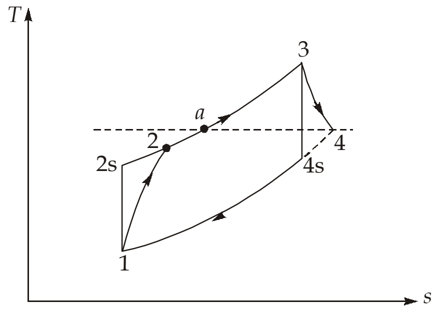
$$\Rightarrow \quad T_3 = 900 \times (6)^{\frac{0.4}{1.4}} = 1501.66 \text{ K}$$

$$T_3 = 1500 \text{ K}$$

$$\text{Ratio} = \frac{T_{max}}{T_{min}} = \frac{T_3}{T_1} = \frac{1500}{300} = 5$$

15. (b)

Given: $T_1 = 15°C = 288$ K. $\eta_C = \eta_T = 0.90$, $T_{2s} = 456.2$ K, $T_3 = 1300$ K, $T_{4s} = 750$ K



Effectiveness of regenerator, $\varepsilon = 0.70$

$$\eta_C = \frac{(T_{2s} - T_1)}{(T_2 - T_1)}$$

$$\Rightarrow \quad T_2 = T_1 + \frac{(T_{2s} - T_1)}{\eta_C} = 288 + \frac{(456.2 - 288)}{0.9} = 474.88 \text{ K}$$

$$\eta_T = \frac{(T_3 - T_4)}{(T_3 - T_{4s})}$$

$$T_4 = T_3 - \eta_T(T_3 - T_{4S}) = 1300 - 0.9(1300 - 750) = 805 \text{ K}$$

$$\Rightarrow \quad \varepsilon = 0.7 = \frac{(T_a - T_2)}{(T_4 - T_2)}$$

$$\Rightarrow \quad T_a = T_2 + 0.7(T_4 - T_2) = 474.88 + 0.7(805 - 474.88)$$

$$T_a = 705.964 \text{ K}$$

$$\eta_{plant} = \frac{W_{net}}{Q_{input}} = \frac{c_p[(T_3 - T_4) - (T_2 - T_1)]}{c_p(T_3 - T_a)}$$

$$= \frac{(1300 - 805) - (474.88 - 288)}{1300 - 705.964} = 0.5186 = 52\%$$

16. (d)

$$\text{Intermediate pressure, } P_i = \sqrt{P_1 P_2}$$

$$= \sqrt{90 \times 1000} = 300 \text{ kPa}$$

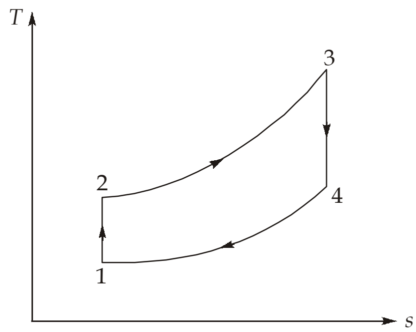
$$\text{Work done} = 2 \times \text{compressor work for single stage}$$

$$= 2\frac{nRT}{(n-1)}\left[\left(\frac{P_i}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

$$= \frac{2 \times 1.4 \times 0.287 \times 300}{(1.4 - 1)}\left[\left(\frac{300}{90}\right)^{\frac{1.4-1}{1.4}} - 1\right] = 247.45 \text{ kJ/kg}$$

17. (d)

Given: T_1 = 300 K, Work ratio, r_w = 0.563



$$\text{For gas turbine cycle, } \eta_{th} = 1 - \frac{T_1}{T_2}$$

$$0.35 = 1 - \frac{300}{T_2}$$

$$T_2 = 461.54 \text{ K}$$

$$\text{Compressor work, } W_C = C_P(T_2 - T_1)$$

$$W_C = 1 \times (461.54 - 300) = 161.54 \text{ kJ/kg}$$

$$\text{Now, } r_w = \frac{\text{Net work}}{\text{Turbine work}} = 0.563$$

$$1 - \frac{W_C}{W_T} = 0.563$$

$$W_T = \frac{W_C}{1 - 0.563} = \frac{161.54}{0.437} = 369.65 \text{ kJ/kg}$$

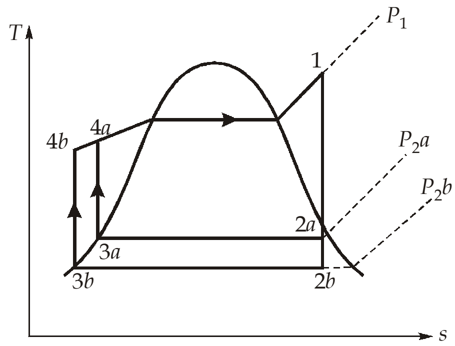
$$\therefore \quad C_P(T_3 - T_4) = 369.65 \text{ kJ/kg}$$

$$\Rightarrow \quad (1 \text{ kJ/kgK}) \times (T_3 - T_4) = 369.65 \text{ kJ/kg}$$

$$\Rightarrow \quad (T_3 - T_4) = 369.65 \text{ K}$$

$\therefore$ Temperature drop across the turbine = $T_3 - T_4$ = 369.65 K

18. (c)



$$h_1 = 3039 \text{ kJ/kg}$$
$$h_{3a} = 192 \text{ kJ/kg}$$
$$h_{3b} = 101 \text{ kJ/kg}$$

Neglecting pump work,

Heat supplied to turbine A = 3039 – 192 = 2847 kJ/kg

Heat supplied to turbine B = 3039 – 101 = 2938 kJ/kg

So, $(WD)_A = 3039 - 2200 = 839$ kJ/kg

$(WD)_B = 3039 - 2000 = 1039$ kJ/kg

So, specific steam consumption of turbine A,

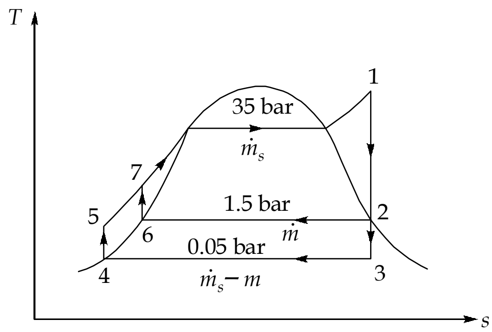
$$(ssc)_A = \frac{3600}{839} = 4.291 \text{ kg/kWh}$$

So, specific steam consumption of turbine B

$$(ssc)_B = \frac{3600}{1039} = 3.465 \text{ kg/kWh}$$

So, reduction in steam consumption = 4.291– 3.465 = 0.826 kg/kWh $\simeq$ 0.83 kg/kWh

19. (b)



$$h_1 = 3445.3 \text{ kJ/kg}$$
$$s_1 = 7.0901 \text{kJ/kgK}, \; h_2 = 2706.9 \text{ kJ/kg}, \; h_6 = h_f = 505 \text{ kJ/kg}$$

For heat exchanger,

$$\dot{m}(h_2 - h_6) = 1.163 \times 10^3$$

$$\dot{m} = \frac{1.163 \times 10^3}{2706.9 - 505} = 0.528 \text{ kg/s}$$

Now,

$$s_1 = (s_f)_{P = 0.05 \text{ bar}} + x_3(s_{fg})_{P = 0.05 \text{ bar}}$$
$$7.0901 = 0.52 + x_3(7.815) \Rightarrow x_3 = 0.84$$

So, $h_3 = 149.79 + 0.84\,(2416) = 2179.23$ kJ/kg

Now, total work output,

$$W_T = \dot{m}_s(h_1 - h_2) + (\dot{m}_s - \dot{m})(h_2 - h_3)$$

$$5.6 \times 10^3 = \dot{m}_s(3445.3 - 2706.9) + (\dot{m}_s - 0.528)(2706.9 - 2179.23)$$

$$\dot{m}_s = 4.64 \text{ kg/s}$$

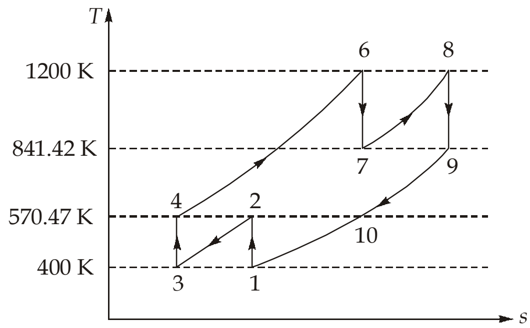
20. (a)

For perfect intercooler, $r_p = \frac{P_2}{P_1} = \frac{P_4}{P_3} = \sqrt{12} = 3.464,$

and $\frac{P_6}{P_7} = \frac{P_8}{P_9} = \sqrt{12} = 3.464,$

$\gamma(\text{air}) = 1.4$

$C_p(\text{air}) = 1.005$ kJ/kg· K



For ideal conditions, work output of each turbine and work input of each compressor would be same.

Now, $T_4 = T_2 = T_1 (r_p)^{\frac{\gamma-1}{\gamma}} = 400(3.464)^{\frac{1.4-1}{1.4}} = 570.47$ K

and $T_9 = T_7 = \frac{T_8}{(r_p)^{\frac{\gamma-1}{\gamma}}} = \frac{1200}{(3.464)^{\frac{1.4-1}{1.4}}} = 841.42$ K

Now, total compressor work $= 2(h_2 - h_1) = 2C_p(T_2 - T_1)$

$= 2 \times 1.005 \times (570.47 - 400)$

$= 342.65$ kJ/kg

and total work of turbine $= 2(h_6 - h_7)$

$= 2C_p(T_6 - T_7)$

$= 2 \times 1.005\ (1200 - 841.42)$

$= 720.74$ kJ/kg

So, back work ratio $= \frac{W_C}{W_T} = \frac{342.65}{720.74} = 0.475$

21. (b)

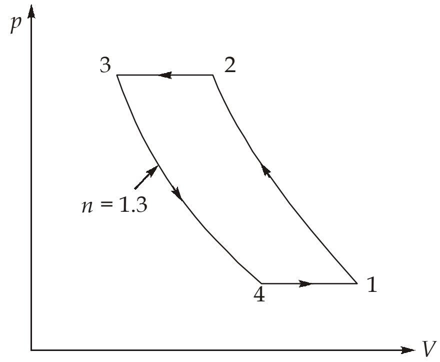
Suction pressure, p_1 = 1.01 bar

Clearance ratio, C = 0.05

Expansion coefficient, n = 1.3

As we know,

$$\text{Volumetric efficiency, } \eta_v = 1 - C\left[\left(\frac{p_2}{p_1}\right)^{1/n} - 1\right]$$



for $\eta_v = 0$,

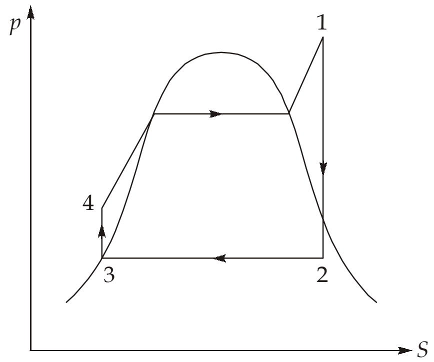
$$0 = 1 - 0.05\left[\left(\frac{p_2}{1.01}\right)^{1/1.3} - 1\right]$$

$$0.05\left[\left(\frac{p_2}{1.01}\right)^{1/1.3} - 1\right] = 1$$

$$\left(\frac{p_2}{1.01}\right)^{1/1.3} = 21$$

$\Rightarrow$ Discharge pressure, p_2 = 52.869 bar

22. (b)



h_1 = 3251 kJ/kg, s_1 = 7.127 kJ/kgK

h_4 = $h_3 = h_f$ = 191.8 kJ/kg [$\because$ Pump work is neglected]

s_4 = $s_3 = s_f$ = 0.6491 kJ/kgK

$$\text{Mean temperature of heat addition, } T_m = \frac{h_1 - h_4}{s_1 - s_4} = \frac{3251 - 191.8}{7.127 - 0.6491}$$

$$= 472.25 \text{ K} = 199.25°\text{C}$$

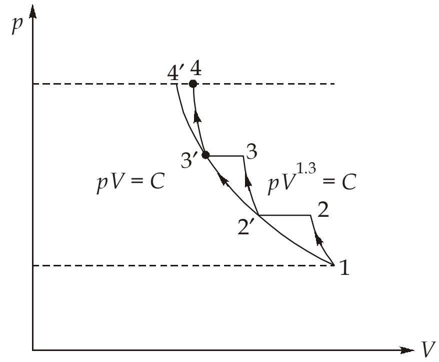
23. (a)

p_1 = 96 kPa

T_1 = 25 + 273 = 298 K

p_4 = 3 MPa

Polytropic index, n = 1.3



$$\text{Compressor work, } W_{poly} = N\left(\frac{n}{n-1}\right)RT_1\left[\left(\frac{p_4}{p_1}\right)^{(n-1)/nN} - 1\right]$$

$$= 3\left(\frac{1.3}{1.3-1}\right)\times 0.287\times 298\left[\left(\frac{3000}{96}\right)^{(1.3-1)/1.3\times 3} - 1\right]$$

$$W_{poly} = 337.0338 \text{ kJ/kg}$$

$$\text{Isothermal work, } W_{iso} = RT_1 \ln\left(\frac{p_4}{p_1}\right)$$

$$W_{iso} = 0.287\times 298 \ln\left(\frac{3000}{96}\right) = 294.382 \text{ kJ/kg}$$

$$\text{Isothermal efficiency, } \eta_{iso} = \frac{W_{iso}}{W_{poly}} = \frac{294.382}{337.0338} = 87.34\%$$

24. (a)

$$\text{Pressure ratio, } r_p = 6.5$$

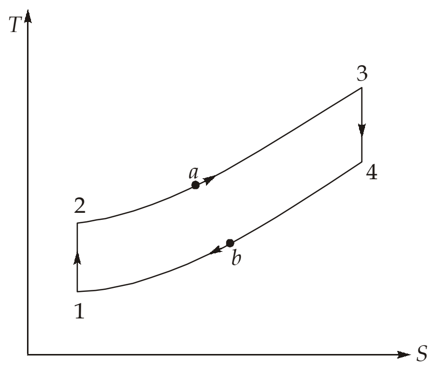
$$T_2 = 550 \text{ K}, \qquad T_3 = 1400 \text{ K}$$

In process 3-4,

$$\frac{T_3}{T_4} = r_p^{(\gamma-1)/\gamma}$$

$$\frac{1400}{T_4} = (6.5)^{\frac{1.4-1}{1.4}}$$

$$T_4 = 820.10 \text{ K}$$



In ideal regerative cycle,

$$T_a = T_4 = 820.10 \text{ K}$$

Heat added in combustion chamber,

$$Q_s = c_p\,(T_3 - T_a) = 1.005\,(1400 - 820.10)$$

$$Q_s = 582.79 \text{ kJ/kg}$$

25. (b)

Given data:

$$h_1 = 3474.1 \text{ kJ/kg}$$

$$s_1 = 7.6027 \text{ kJ/kgK}$$

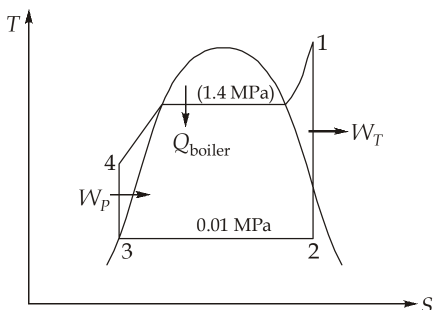
$$h_3 = (h_f) \text{ at } 0.01 \text{ MPa}$$

$$= 191.81 \text{ kJ/kg}$$

Process 1-2 is isentropic,

$$\therefore \quad s_1 = s_2$$

$$7.6027 = (s_f + x s_{fg}) \text{ at } 0.01 \text{ MPa},$$



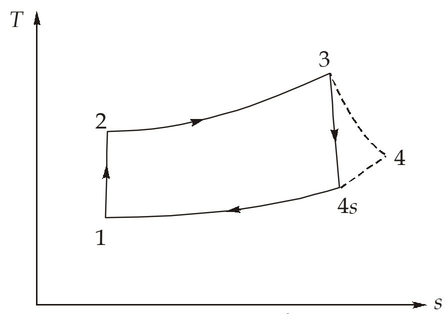
Ideal Rankine cycle

(where x = Dryness fraction)

$$7.6027 = 0.6492 + x(8.1454 - 0.6492)$$
$$x = 0.9276$$
$$h_2 = (h_f + xh_{fg}) \text{ at } 0.01 \text{ MPa}$$
$$= 191.81 + 0.927 \times (2583.9 - 191.81)$$
$$h_2 = 2410.72 \text{ kJ/kg}$$
$$W_P = h_4 - h_3 = v_3 dP = v_3(P_4 - P_3) \qquad (P_4 = P_1 = 1.4 \text{ MPa}, P_3 = 0.01 \text{ MPa})$$
$$W_P = h_4 - h_3 = 0.00101\,(1.4 - 0.01) \times 1000 \text{ kJ/kg}$$
$$W_P = h_4 - h_3 = 1.404 \text{ kJ/kg}$$
$$h_4 = h_3 + W_P = h_3 + 1.404 = 191.81 + 1.404$$
$$h_4 = 193.214 \text{ kJ/kg}$$
$$\eta_{cycle} = \frac{W_{net}}{Q_{input}} = \frac{W_T - W_P}{Q_{boiler}}$$
$$= \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)} = \frac{(3474.1 - 2410.72) - (1.404)}{(3474.1 - 193.214)}$$
$$= \frac{1061.976}{3280.886} = 0.3236 \text{ or } 32.36\%$$

26. (d)

Given: $T_3 = 1450$ K, $c_p = 1.00$ kJ/kgK,
$c_v = 0.769$ kJ/kgK



Brayton cycle

$$\gamma(\text{Adiabatic index}) = \frac{c_p}{c_v} = \frac{1}{0.769}$$
$$\gamma = 1.3$$
$$\frac{T_3}{T_{4s}} = \left(\frac{P_3}{P_4}\right)^{\frac{\gamma-1}{\gamma}}$$
$$\Rightarrow \quad \frac{1450}{T_{4s}} = \left(\frac{20}{1}\right)^{\frac{1.3-1}{1.3}}$$
$$\Rightarrow \quad T_{4s} = 726.324 \text{ K}$$
$$\text{Isentropic efficiency, } \eta_T = \frac{(T_3 - T_4)}{(T_3 - T_{4s})}$$
$$0.90 = \frac{(1450 - T_4)}{(1450 - 726.324)}$$
$$T_4 = 798.6916 \text{ K}$$

Work developed by turbine, $W = c_p\,(T_3 - T_4)$
$$W = 1(1450 - 798.6916)$$
$$W = 651.3084 \text{ kJ/kg}$$

27. (c)

Given:
$P_1 = 1$ bar, $T_1 = 30 + 273 = 303$ K,
$P_2 = 4.9$ bar, $T_2 = 181 + 273 = 454$ K,
$V_2 = 90$ m/s, $V_1 = 0$ m/s,
$c_p = 1.005$ kJ/kgK, $R = 0.287$ kJ/kgK

Actual work of compression,

$$W_a = (h_1 - h_2) - \left(\frac{V_2^2}{2}\right) \quad \text{[By SFEE]}$$

$$= c_p(T_1 - T_2) - \frac{90^2}{2 \times 1000}$$

$$= 1.005 \times (303 - 454) - \frac{8100}{2000}$$

$$= -155.805 \text{ kJ/kg}$$

Isothermal work of compression,

$$W_T = \int_1^2 v\,dP - \frac{V_2^2}{2000} = -RT_1 \ln\left(\frac{P_2}{P_1}\right) - \frac{V_2^2}{2000}$$

$$= -0.287 \times 303 \ln(4.9) - \frac{90^2}{2000}$$

$$= -138.201 - 4.05$$

$$W_T = -142.251 \text{ kJ/kg}$$

$$\text{Isothermal efficiency, } \eta_T = \frac{W_T}{W_a} = \frac{-142.251}{-155.805} = 0.913 = 91.3\%$$

28. (a)

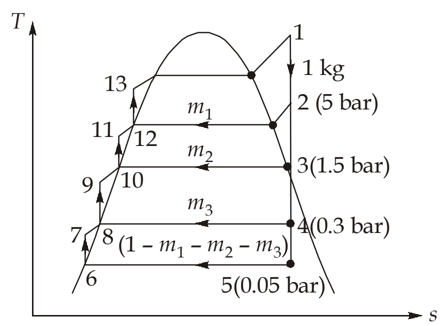
Given:
$\beta_1 = 51°$, $\beta_2 = 10°$
$U = 160$ m/s, $V_f = 109.06$ m/s

$$\text{Degree of reaction, } (\Omega) = \frac{V_f}{2U}(\tan\beta_1 + \tan\beta_2) = \frac{109.06}{2 \times 160}(\tan 51° + \tan 10°)$$

$$\Omega = 0.48$$

29. (d)

$h_1 = 2905$ kJ/kg, $h_2 = 2600$ kJ/kg, $h_3 = 2430$ kJ/kg,
$h_4 = 2210$ kJ/kg, $h_5 = 2000$ kJ/kg,
$h_6 \approx h_7 = 137.8$ kJ/kg,
$h_8 \approx h_9 = 289.3$ kJ/kg,
$h_{10} \approx h_{11} = 467.8$ kJ/kg,
$h_{12} \approx h_{13} = 640.1$ kJ/kg,



Energy balance in first FWH

$$m_1 h_2 + (1 - m_1)h_{11} = h_{12}$$

$$m_1 = \frac{h_{12} - h_{11}}{h_2 - h_{11}} = \frac{640.1 - 467.1}{2600 - 467.1} = 0.081 \text{ kJ/kg}$$

$$m_1 = 0.081 \text{ kJ/kg of entering steam}$$

Energy balance in second FWH

$$m_2h_3 + (1 - m_1 - m_2)h_9 = h_{10}$$

$$m_2 = \frac{h_{10} - (1 - m_1)h_9}{h_3 - h_9} = \frac{467.1 - (1 - 0.081) \times 289.3}{2430 - 289.3}$$

$$m_2 = 0.09 \text{ kJ/kg of entering steam}$$

Energy balance in third FWH

$$m_3h_4 + (1 - m_1 - m_2 - m_3)h_7 = h_8$$

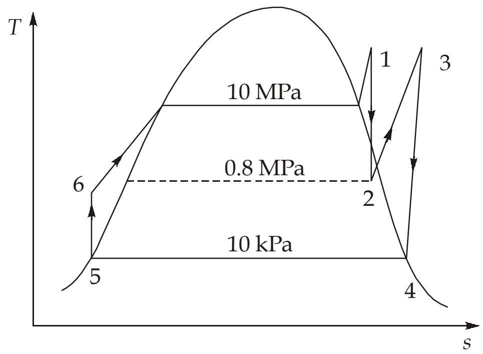
$$m_3 = \frac{h_8 - (1 - m_1 - m_2)h_7}{h_4 - h_7} = \frac{289.3 - (1 - 0.081 - 0.09) \times 137.8}{2210 - 137.8}$$

$$m_3 = 0.0844 \text{ kJ/kg of entering steam}$$

30. (b)

At 10 MPa, 500°C

$$h_1 = 3343.6 \text{ kJ/kg}, S_1 = 6.4651 \text{ kJ/kgK}$$



At 0.8 MPa and 500°C,

$$h_3 = 34813 \text{ kJ/kg}$$

$$S_3 = 7.8692 \text{ kJ/kgK}$$

At 10 kPa, [exit of low pressure turbine]

$$S_4 = S_3 = S_{f4} + x_4S_{fg4}$$

From steam table data

$$x_4 = \frac{7.8692 - 0.6492}{7.4996} = 0.96271$$

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