ACE Engineering Academy

Head Office : Sree Sindhi Guru Sangat Sabha Association, # 4-1-1236/1/A, King Koti, Abids, Hyderabad - 500001.

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ESE- 2020 (Prelims) - Offline Test Series Test - 9

MECHANICAL ENGINEERING

Subject: Fluid Mechanics + Turbo machinery — SOLUTIONS

01. Ans: (b)

Sol: The frictional loss depends on loss in kinetic energy with respect to bucket. It is given by

$$h_{fb} = \frac{V_{r1}^2 - V_{r2}^2}{2g} = \frac{V_{r1}^2 - (kV_{r1})^2}{2g}$$

$$= \frac{V_{r1}^2(1-k^2)}{2g}$$

$$= \frac{(V-u)^2}{2g}(1-k^2)$$

$$= \frac{(90-40)^2}{2\times 9.81}\times(1-0.95^2) = 12.4\text{ m}$$

02. Ans: (d)

Sol: The number of buckets on wheel (z) is given as:

$$Z = 0.5\left(\frac{D}{d}\right) + 15 \rightarrow \text{Taygun's formula}$$

$$= 0.5\times\frac{2.4}{0.12} + 15 = 25$$

03. Ans: (b)

Sol: The Euler's equation of turbine is derived from the principle of angular momentum i.e., moment of linear momentum.

04. Ans: (d)

Sol: The minimum permissible NPSH is given by:

$NPSHR = \sigma_c H_m$

$= 0.1\times 30 = 3$ m

$\therefore \quad H_a - H_{s,\,max} - H_v - h_{fs} = 3$m

i.e., $10.3 - H_{s,\,max} - 0.3 - 0.5 = 3$

$\Rightarrow \quad H_{s,\,max} = 6.5$ m

05. Ans: (c)

Sol: The efficiency of the torque converter is given by,

$$\eta = \frac{T_2\omega_2}{T_1\omega_1} = \frac{T_2N_2}{T_1N_1} = \frac{8\times 450}{5\times 800} = 0.9$$

06. Ans: (a)

Sol:

- Divided full power plants makes optimal use of geographical terrain.
- Run of river plants have small storage hence low environmental impact.
- Pumped storage plants are used for load balancing hence they are operational only when power demand is high.
- Thermal power plants can be operational throughout the year and they act as base load plants.

07. Ans: (b)

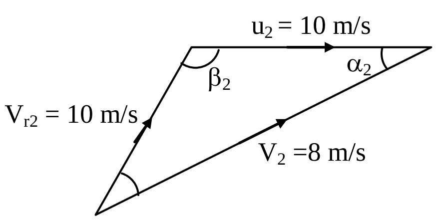
Sol: The shaft power (S.P) required to drive the pump is given by,

$$S.P = \frac{\rho g Q H}{\eta_0} = \frac{800\times 9.81\times 0.025\times 12}{0.75}$$

$$= 3.14\text{ kW}$$

08. Ans: (a)

Sol:



As 18 m/s is vector sum of other two vectors, it must be absolute velocity.

As $\beta_2 > 90^\circ$ (or $V_{w2} > u_2$),

It is forward vane impeller

From the velocity triangle,

$$\cos\beta_2 = \frac{V_{r2}^2 + u_2^2 - V_2^2}{2\times V_{r2}u_2}$$

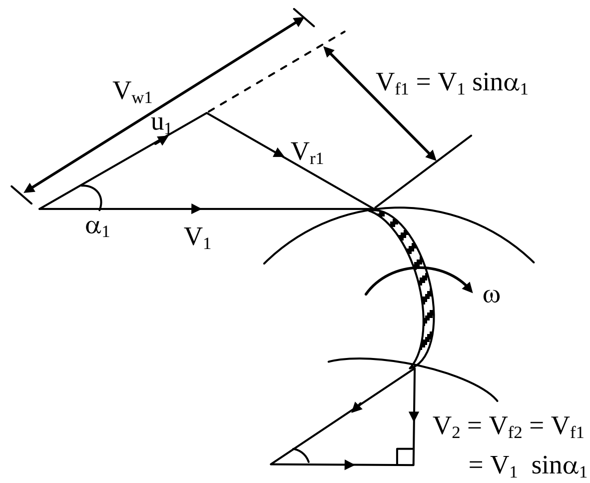
$$= \frac{10^2 + 10^2 - 18^2}{2\times 10\times 10} = -0.62$$

$$\Rightarrow \beta_2 = \cos^{-1}(-0.62) = 128^\circ$$

Note: As angle β_2 is obtuse as per diagram the options (b) and (d) can be directly eliminated.

09. Ans: (a)

Sol:



$$R = \frac{(P_1 - P_2)/\rho g}{H_e} = 1 - \frac{(V_1^2 - V_2^2)/2g}{H_e}$$

$$\left[\because H_e = \frac{P_1 - P_2}{\rho g} + \frac{V_1^2 - V_2^2}{2g}\right]$$

$$\frac{1}{2} = 1 - \frac{(V_1^2 - V_2^2)/2g}{u_1 V_{w1}/g}$$

$$\text{i.e}\ \frac{1}{2} = \frac{V_1^2 - V_2^2}{2u_1 V_{w1}}$$

$$u_1 = \frac{V_1^2 - (V_1 \sin\alpha_1)^2}{V_1 \cos\alpha_1} = \frac{V_1(1-\sin^2\alpha_1)}{\cos\alpha_1}$$

$$u_1 = V_1 \cos\alpha_1$$

10. Ans: (d)

Sol: Given, $\mu = 0.0014$ Ns/m^2

V = 0.2 m/sec,

Area of plate (A) = 0.15 m^2

Gap between the plates (y) = 0.0002 m

$$\tau = 0.0014 \times \frac{0.2}{0.0002} = 1.4\ \text{N/m}^2$$

Shear force = $\tau \times A$

= 1.4 × 0.15 = 0.21 N

Power required to maintain the flow

P = Shear force × velocity

= 0.21 × 0.2 = 0.042 W

11. Ans: (c)

Sol: A source of low temperature air as inlet to compressor will give minimum compressor work.

12. Ans: (d)

13. Ans: (b)

Sol: Ramjet is not self operating at zero flight speed.

14. Ans: (d)

Sol: Density of fluid is increased by 5% or greater in centrifugal compressors.

15. Ans: (c)

Sol: The ratio of isentropic work to Euler's work in a centrifugal compressor is called pressure coefficient.

16. Ans: (a)

Sol: Axial flow compressors may have both drum type or disc type rotor.

17. Ans: (d)

Sol: At this compression there will be no delivery of air.

18. Ans: (c)

Sol:

- In the first stage in a multistage machine the axial direction of the approaching flow is changed to the desired direction (α_1) by providing a row of blades upstream of the rotor which are called inlet guide vanes or upstream guide vanes. Therefore, the first stage experiences additional losses arising from flow through the guide vanes.
- Owing to secondary flows and the growth of boundary layers on the hub and casing of the compressor annulus, the axial velocity along the blade height is far from uniform. However, this effect is not so prominent in the first stage of a multistage machine but is quite significant in the subsequent stages.

- The work done factor accounts for the effect of boundary layer and tip clearance. It is an empirical factor which reduces the capacity of compressor. It takes into account the axial velocity distribution also which is otherwise assumed constant.

19. Ans: (b)

Sol: The velocity at exit from the convergent nozzle is sonic when the exit properties are critical properties and the discharge is maximum.

20. Ans: (b)

Sol: $T'_{02} = T_{01}\left(\frac{P_{02}}{P_{01}}\right)^{\frac{\gamma}{\gamma-1}} = 300(4)^{\frac{0.4}{1.4}}$

$= 300 \times 4^{0.286}$

$= 300 \times \frac{4^{1.286}}{4}$

$= 300 \times \frac{5.946}{4}$

$= 445.95 \text{ K} \approx 446 \text{ K}$

$$\eta = \frac{446-300}{480-300} = 0.81$$

21. Ans: (d)

Sol: Unit speed remains same under homologous conditions. Individual values of N and H may change.

$$N_u = \frac{N_1}{\sqrt{H_1}} = \frac{N_2}{\sqrt{H_2}}$$

22. Ans: (c)

Sol: In Francis turbine pressure is partially dropped across guide vanes and remaining pressure is dropped across runner. Guide vanes act like nozzle hence absolute velocity increases across guide vanes.

23. Ans: (c)

Sol: $Q \propto D^2\sqrt{H} \propto D^2(ND) \quad \left\{\because ND \propto \sqrt{H}\right\}$

$\propto D^3N$

$P \propto D^2H^{3/2} \propto D^2(ND)^3 \quad \left\{\because ND \propto \sqrt{H}\right\}$

$\propto D^5N^3$

24. Ans: (b)

Sol: When the tube is accelerated by acceleration a in right direction, pressure increases from C to D and increases in pressure is ρ a h_{CD}

$\therefore \quad P_D = P_C + \rho a h_{CD} = P_{atm} + \rho a h_{CD} \rightarrow (1)$

But $P_D = P_B + \rho g h_{BD} = P_{atm} + \rho g h_{BD} \rightarrow (2)$

$\therefore$ From (1) and (2)

$P_{atm} + \rho a h_{CD} = P_{atm} + \rho g h_{BD}$

$\therefore \quad a = g \times \frac{h_{BD}}{h_{CD}} = 10 \times \frac{25}{30} = 8.33 \text{ m/s}^2$

25. Ans: (c)

Sol: $F_H = P_{C.G}\,.\,A_{proj} = \rho g(2R)\times \pi R^2$

$$= 2\rho g \pi R^3$$

$$F_V = \rho g V = \rho g \times \frac{2}{3}\times \pi R^3$$

$$F_R = \sqrt{F_H^2 + F_V^2} = \rho g \pi R^3\sqrt{2^2 + \left(\frac{2}{3}\right)^2}$$

$$= \frac{2\sqrt{10}}{\sqrt{3}}\rho g \pi R^3$$

26. Ans: (d)

Sol:

- When size of object is very large as compared to mean free path the continuum hypothesis is applicable.
- Continuum hypothesis does not talk about inter molecular forces.

27. Ans: (d)

Sol: $h^* - \bar{h} = \dfrac{I_G \sin^2\theta}{A\bar{h}} = \dfrac{\dfrac{\pi R^2}{8}\times 1}{\dfrac{\pi R^2}{2}\times R} = \dfrac{R}{4}$

28. Ans: (b)

Sol: Required work = Increases in surface energy

$$= \sigma(A_2 - A_1) = \sigma\times\left(4\pi R_2^2 - 4\pi R_1^2\right)\times 2$$

$$= 8\pi\sigma\times\left[(2R)^2 - R^2\right]$$

$$= 24\pi\sigma R^2$$

29. Ans: (c)

Sol: $\nabla.\left(\rho\vec{V}\right) + \dfrac{\partial\rho}{\partial t} = \rho\nabla.\vec{V} + \vec{V}.\nabla\rho + \dfrac{\partial\rho}{\partial t}$

$$= \rho\,\nabla.\,\vec{V} + \frac{D\rho}{Dt}$$

Hence, both of the above equations are equivalent and both of them represent continuity equation in differential form.

30. Ans: (a)

Sol: $d\psi = \dfrac{\partial\psi}{\partial x}dx + \dfrac{\partial\psi}{\partial y}dy = vdx - udy$

$$= 3x^2\,dx + 3y^2\,dy$$

$$\psi = \int 3x^2 dx + \int 3y^2 dy + C$$

$$\psi = x^3 + y^3 + C$$

$\dfrac{Q}{b} = |\psi_2 - \psi_1|$ *where b is the width*

$$= \left|\left(1^3 + 2^3 + C\right) - \left(0^3 + 0^3 + C\right)\right| = 9\ m^2/s$$

31. Ans: (b)

Sol: $a_r = u_r\dfrac{\partial u_r}{\partial r} + \dfrac{u_\theta}{r}\dfrac{\partial u_r}{\partial\theta} - \dfrac{u_\theta^2}{2} + \dfrac{\partial u_r}{\partial t}$

$$= \left(-\frac{k}{r}\right)\frac{\partial}{\partial r}\left(-\frac{k}{r}\right) - \frac{\left(\frac{k}{r}\right)^2}{r}$$

$$= \left(-\frac{k}{r}\right)\left(\frac{k}{r^2}\right) - \frac{k^2}{r^3}$$

$$= -\frac{2k^2}{r^3} = -\frac{2k^2}{1^3} = -2k^2$$

32. Ans: (a)

Sol: The curve $(x-1)^2 + (y+2)^2 = 16$ represents a circle with centre (1, –2) and radius '4'.

$$\Gamma = \oint \vec{V}.\vec{ds} = \iint \vec{\Omega}.\vec{dA} = \iint \Omega_z \, dA$$

$$[\because \Omega_x = \Omega_y = 0 \text{ for flow in xy plane}]$$

$$\Omega_z = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} = 5 - 3 = 2\,\text{rad/s}$$

$$\Gamma = 2 \times \iint dA$$

$$= 2 \times \pi \times 4^2$$

$$= 32\,\pi$$

33. Ans: (a)

Sol: Irrotational flow is not a necessary assumption for Bernoulli's equation. In fact if flow is irrotational, Bernoulli's equation can be applied between any two points even though they are not on the same streamline.

34. Ans: (a)

Sol: The kinetic energy correction factor is given as:

$$\alpha = \frac{\int u^3 dA}{AV^3}$$

$$V = \frac{U_\infty + 0}{2} = \frac{U_\infty}{2}$$

$$u = \frac{U_\infty}{h} y = ky \quad [\text{ where } k = \frac{U_\infty}{h}]$$

$A = bh$

where, b = width perpendicular to plane of diagram.

$$\alpha = \frac{\int_0^h (ky)^3 \, b\,dy}{(bh) \times \left(\frac{U_\infty}{2}\right)^3}$$

$$= \frac{8}{bhU_\infty{}^3} \times bk^3 \times \left[\frac{y^4}{4}\right]_0^h$$

$$= \frac{2k^3}{hU_\infty^3} \times h^4$$

$$= 2 \times \frac{(kh)^3}{U_\infty^3} \;\; = 2\frac{U_\infty^3}{U_\infty^3} \;\; = 2$$

35. Ans: (b)

Sol: The jet performs projectile motion hence horizontal component of velocity (u) remains constant throughout. At topmost point, only horizontal component is present.

$\therefore\ V_2 = u = V_1 \cos\theta = 18 \times \cos 30° = 9$ m/s

By continuity equation,

$A_1V_1 = A_2V_2$

$$V_2 = \frac{A_1}{A_2} V_1 = \left(\frac{d_1}{d_2}\right)^2 V_1$$

$$d_2 = d_1 \sqrt{\frac{V_1}{V_2}}$$

$$= 6\sqrt{2} = 8.49 \text{ cm}$$

36. Ans: (d)

Sol: By applying Bernoulli's equation between (1) and (2) along streamline passing through axis,

$$\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2+h_f$$

$$\frac{V_2^2-V_1^2}{2g}=\frac{P_1-P_2}{\rho g}-h_f = 0.2 - 0.05$$

i.e, $\frac{V_2^2-V_1^2}{2g}=0.15$ ------- (i)

From continuity equation:

$$A_1V_1 = A_2 V_2$$

$$V_2=\frac{A_1}{A_2}V_1=\left(\frac{d_1}{d_2}\right)^2 V_1$$

$$=\left(\frac{10}{5}\right)^2 V_1=4V_1$$

$\therefore$ $(4V_1)^2 - V_1^2 = 2 \times 10 \times 0.15$

$15\ V_1^2 = 2\times10\times0.15$

$V_1^2 = 0.2$

$V_1=\sqrt{0.2\times10^4} = 20\sqrt{5}$ cm/s

$Q = A_2\ V_2$

$$=\frac{\pi}{4}\times5^2\times20\times\sqrt{5}$$

$= 125\pi\sqrt{5}$ cm^3/s

37. Ans: (c)

Sol: By angular momentum equation,

$$T=\frac{\rho Q}{2}V_1 r_1+\frac{\rho Q}{2}V_2 r_2$$

$= \rho Q\ V_1\ r_1$

[$\because$ $V_1 = V_2$ & $r_1 = r_2$ due to symmetry]

But T = 0

$\Rightarrow V_1 = 0$. Hence statement (1) is correct.

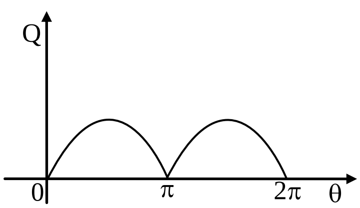
The discharge depends upon relative velocity of water with respect to nozzle.

$$V_{r1}=\frac{Q}{A}=\frac{0.5\times10^{-3}}{0.5\times10^{-4}} = 10 \text{ m/s}$$

Hence, statement (2) is also correct.

38. Ans: (b)

Sol: The discharge delivered by double acting reciprocating pump is variable due to variable piston speed. It is continuously present due to simultaneous action on both sides of piston.



39. Ans: (d)

Sol: $h_f=\frac{\Delta P}{\rho g}=\frac{32\mu VL}{\rho g D^2}=\frac{128\mu QL}{\pi\rho g D^4}$

$h_f \propto D^{-4}$

Note: If Darcy-Weishach equation is used then the friction factor for laminar flow should be considered $\frac{64}{Re}$.

$$\therefore\ h_f = \frac{f L V^2}{2gD} = \frac{64}{Re}\times\frac{LV^2}{2gD}$$

$$= \frac{64\mu}{\rho VD}\times\frac{LV^2}{2gD}$$

$$= \frac{32\mu VL}{\rho g D^2}$$

$$= \frac{128\,\mu QL}{\pi\rho g D^4}$$

40. Ans: (b)

Sol: Let 'q' be the discharge in each of the smaller pipe and Q be discharge in bigger pipe.

$$h_{f1} = h_{f2}$$

$$\frac{f L Q^2}{12.1 D^5} = \frac{f L q^2}{12.1\left(\frac{D}{2}\right)^5}$$

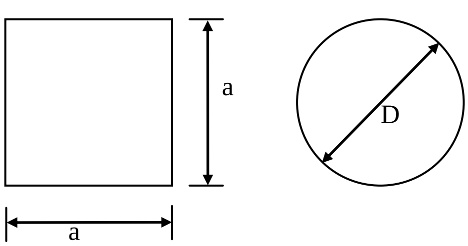
$$q^2 = \frac{Q^2}{32}$$

$$q = \frac{Q}{4\sqrt{2}}$$

$$\frac{8q}{Q} = \frac{\left(\frac{8Q}{4\sqrt{2}}\right)}{Q} = \sqrt{2}$$

41. Ans: (a)

Sol:



$$D_h = \frac{4A_s}{P_s} = \frac{4\times a^2}{4a} = a$$

$A_S = A_C$

$$a^2 = \frac{\pi}{4}D^2$$

$$a = \frac{\sqrt{\pi}D}{2}$$

$$\frac{h_{fs}}{h_{fc}} = \frac{f L V_s^2 / 2gD_h}{f L V_c^2 / 2gD}$$

$$= \left(\frac{V_s}{V_c}\right)^2 \times \left(\frac{D}{D_h}\right)$$

$$= \left(\frac{Q_s}{A_s}\right)^2 \times \left(\frac{A_c}{Q_c}\right)^2 \times \frac{D}{a}$$

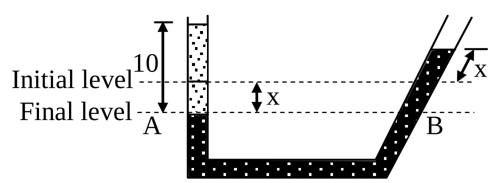
$$= \frac{2}{\sqrt{\pi}}\quad [\because Q_s = Q_c \text{ and } A_s = A_c]$$

42. Ans: (b)

Sol: Sum of discharges at a junction is zero. Sum of discharges around a loop may not be zero.

43. Ans: (b)

Sol:



$P_A = P_B$

$$800 \times g \times 10 = 1000 \times (x + x\sin\theta) \times g$$

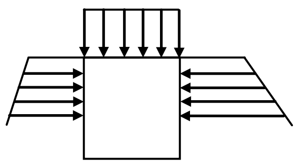
$$x + \frac{x}{2} = 8$$

$$\frac{3}{2}x = 8$$

$$x = \frac{16}{3} = 5.33 \text{ cm}$$

44. Ans: (d)

Sol:



The force exerted by water will be due to the pressure on upper face as shown in the figure.

$F = P\,A = 1000 \times 10 \times 5 \times 10^{-2} \times 10 \times 10^{-4}$

$= 0.5$ N (downward)

45. Ans: (a)

Sol: The ball will be retarded after the impact due to drag force exerted by air.

$$a = -\frac{F_D}{m} = -\frac{C_D}{2}\frac{\rho A V_\infty^2}{m}$$

$$= -\frac{0.5}{2} \times \frac{1.2 \times \pi \times 0.02^2 \times 30^2}{3 \times 10^{-3}}$$

$= -36\pi$ m/s^2

46 Ans: (b)

Sol:

- Strouhl number $\left(St = \frac{f\,D}{U_\infty}\right)$ is related to flow induced vibrations.
- Knudsen number $\left(Kn = \frac{\lambda}{L}\right)$ is used to verify validity of continuum hypothesis.
- Mach number $\left(Ma = \frac{V}{C}\right)$ is related to water hammer.
- Thoma's number $\left(\sigma = \frac{NPSH}{H}\right)$ is related to cavitation.

47. Ans: (d)

Sol: For thin airfoils, $C_L = 2\pi\alpha$

For turbulent boundary layer, $C_D = \dfrac{0.074}{Re^{0.2}}$

48. Ans: (d)

Sol: For linear velocity profile, $\dfrac{u}{U_\infty} = \dfrac{y}{\delta}$

$$\theta = \int_0^\delta \frac{u}{U_\infty}\left(1 - \frac{u}{U_\infty}\right)dy = \int_0^\delta \frac{y}{\delta}\left(1 - \frac{y}{\delta}\right)dy$$

Let $\dfrac{y}{\delta} = \eta$,

$\therefore$ dy = $\delta d\eta$,

at y = 0, η = 0 and at y = δ, η = 1.

$$\theta = \delta\int_0^1 \eta(1-\eta) = \int_0^1 \left(\eta - \eta^2\right)d\eta$$

$$\frac{\theta}{\delta} = \left[\frac{\eta^2}{2} - \frac{\eta^3}{3}\right]_0^1$$

$$\frac{\theta}{\delta} = \left[\frac{1}{2} - \frac{1}{3}\right] = \frac{1}{6}$$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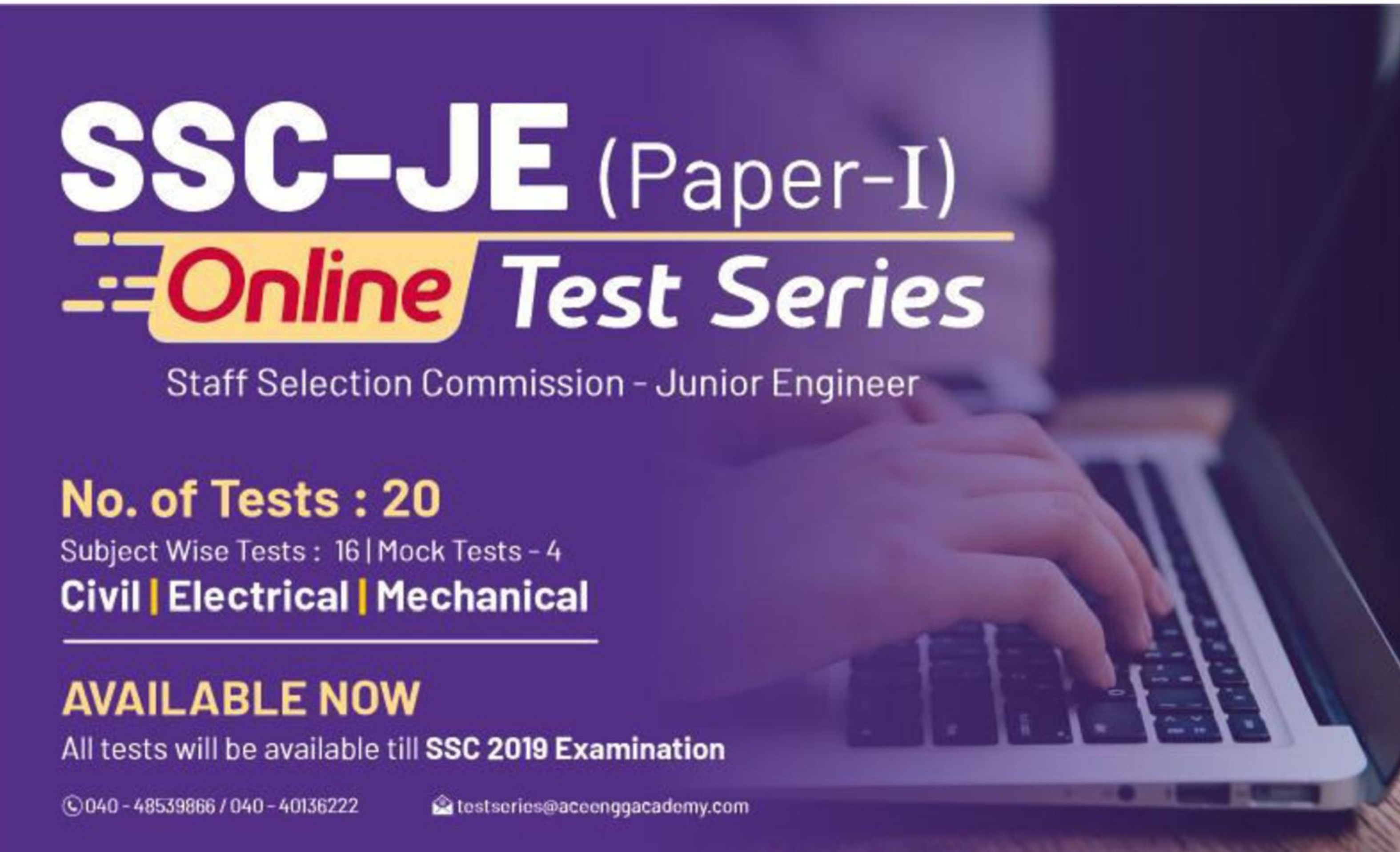
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49. Ans: (c)

Sol: Turbulent boundary layer has more momentum flux hence it can sustain adverse pressure gradient over a longer distance.

50. Ans: (a)

Sol: $\delta_t = \dfrac{0.38x}{(Re_x)^{1/5}} \propto x^{4/5}$

$$\delta_\ell = \frac{5x}{\sqrt{Re_x}} \propto x^{1/2}$$

$$\frac{\delta_t}{\delta_\ell} \propto \frac{x^{4/5}}{x^{1/2}} \propto x^{0.3}$$

51. Ans: (c)

52. Ans: (a)

Sol: Due to drag force momentum of the fluid is lost near to surface. Hence option (a) is most appropriate.

53. Ans: (c)

Sol: In Francis turbine, blade velocity and absolute velocity are perpendicular to the each other. Absolute velocity is vector sum of blade velocity and relative velocity.

$$\vec{V} = \vec{u} + \vec{V}_r$$

54. Ans: (a)

Sol: Air vessels maintain constant velocity in the pipe. As acceleration of the fluid in pipe is zero the acceleration head is eliminated. Therefore, the minimum pressure at the beginning of suction stroke is increased.

55. Ans: (d)

Sol: The maximum head is developed by the centrifugal pump when discharge through pump is zero. At this condition efficiency of the pump is also zero.

56. Ans: (b)

57. Ans: (a)

58. Ans: (b)

59. Ans: (a)

Sol: A pressure ratio of the order of 4 : 1 can be obtained from a single stage, manufactured using conventional materials. This is adequate for a heat exchange cycle when the turbine inlet temperature is in the region of 1000-1200 K. Thus, it can find an application in small power units. It is mainly because the higher isentropic efficiency of axial compressors cannot be maintained for every small size of machines.

60. Ans: (b)

Sol: The impeller of a centrifugal compressor has the following components.

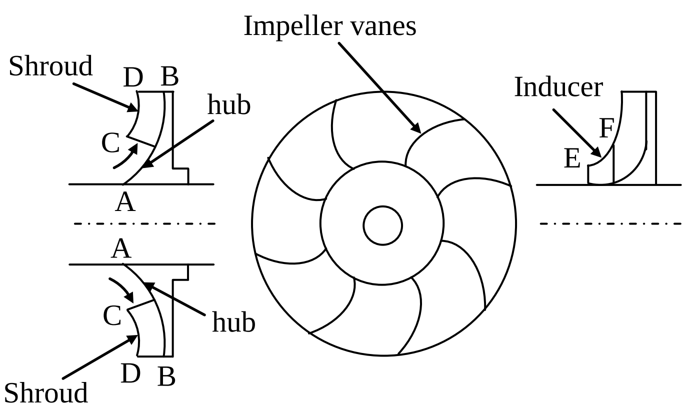
(i) The impeller vanes

(ii) The hub

(iii) The shroud

(iv) The inducer.

The components are shown in the figure below.



61. Ans: (a)

Sol: As kaplan turbine blades are adjustable, they can be adjusted according to discharge in such a way that the relative velocity is tangential to the blade. This ensures the flow enters shock free even at part load.

62. Ans: (d)

Sol: TEL always falls in the direction of flow because energy of fluid decreases due to various losses but HGL may rise or fall depending upon whether velocity is decreasing or increasing in the flow passage.

63. Ans: (a)

Sol: In water hammer phenomen, the conversion of kinetic energy into strain energy of compressed liquid is responsible for pressure rise. If pipe is elastic then some part of kinetic energy is converted into strain energy of pipe. Hence liquid pressure rise is less.

64. Ans: (d)

Sol: For turbulent flow through smooth pipe,

$$f = \frac{0.3164}{Re^{0.25}} \propto \frac{1}{V^{0.25}}$$

Hence statement (II) is correct.

$$h_f = \frac{f\,L\,V^2}{2gD} = \frac{0.3164}{Re^{0.25}} \times \frac{LV^2}{2gD} \propto V^{1.75}$$

Hence, statement (I) is wrong.

65. Ans: (c)

Sol: $$\delta(x) = \frac{5x}{\sqrt{Re_x}} = \frac{5x}{\sqrt{\frac{\rho U_\infty x}{\mu}}} = k\sqrt{x}$$

i.e., $\delta^2(x) = k^2\,x$

$\Rightarrow$ $\delta(x)$ varies parabolically w.r.t x.

As per Blausius solution velocity profile of laminar boundary layer doesn't have any definition because Blasius equation which governs laminar boundary layer cannot be solved analytically.

66. Ans: (d)

Sol: Velocity gradient in normal direction is high due to reason explained in statement (II). The meaning of statement (I) is exactly opposite.

67. Ans: (d)

Sol: Even though turbulence created by rough surface has high friction drag overall drag will be less due to reduction in pressure drag. Turbulence delays flow separation and reduces size of wake due to which pressure drag reduces.

68. Ans: (d)

Sol: Angular velocity (ω_z) in polar coordinate system is given by

$$\omega_z = \frac{1}{2r}\left[\frac{\partial}{\partial r}(ru_\theta) - \frac{\partial u_r}{\partial \theta}\right]$$

$$= \frac{1}{2r}\left[\frac{\partial}{\partial r}\left(r \times \frac{k}{r}\right) - \frac{\partial}{\partial \theta}(0)\right]$$

$$= 0$$

$\Rightarrow$ Free vortex is irrotational.

In irrotational flow Bernoulli's equation can be applied between any two points even though they are not on same streamline.

69. Ans: (a)

Sol: If rotameter is installed in horizontal position then the drag exerted by flowing fluid on rotameter cannot be balanced by other fluid.

70. Ans: (a)

Sol: In turbulent flow effective viscosity is sum of dynamic viscosity and eddy viscosity. The eddy viscosity is present due to Reynolds stresses.

71. Ans: (c)

Sol: $C_d = C_c \times C_v$

$$[\because\ C_d = \frac{Q}{Q_{th}} = \frac{A.V}{A_{th}V_{th}} = C_c \times C_v\ ]$$

72. Ans: (a)

Sol: The Navier-stokes equation in 'x' direction is

$$\mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right) - \frac{\partial P}{\partial x} = \rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right)$$

For laminar flow between two large parallel plates,

$u = u(y)$ and $P = P(x)$

$$\therefore\ \mu\frac{d^2u}{dy^2} = \frac{dP}{dx}$$

when $\dfrac{dP}{dx} = 0$

$$\frac{d^2u}{dy^2} = 0$$

or $u = c_1 y + c_2$

73. Ans: (a)

Sol: Y-axis in Mohr's circle represents shear stress. As shear stresses are zero in ideal flow, radius of Mohr's circle must be zero.

74. Ans: (d)

Sol: For Newtonain fluid viscosity is constant for any value of velocity gradient.

i.e., $\tau \propto \frac{du}{dy}$

$$\mu = \frac{\tau}{\left(\frac{du}{dy}\right)} = \text{constant.}$$

75. Ans: (c)

Sol: Concept of meta centre is not applicable for completely submerged body.