① $\eta_d = \frac{T_{02s} - T_a}{T_{02} - T_a}$ Ans (A)

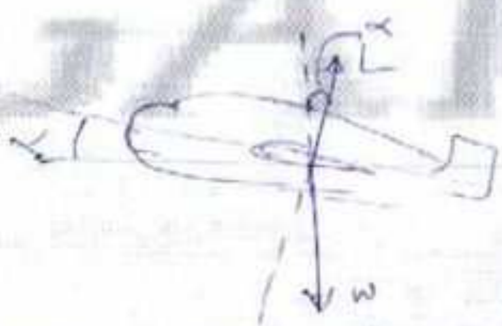
② $a = \cos\theta$, $b = \sin\theta$ $a^2 + b^2 = 1$

Also $|\vec{V_2}| = \begin{vmatrix} a & -b \\ b & a \end{vmatrix} |\vec{V_1}| = |\vec{V_1}|$

Hence $\vec{V_2}$ obtained by rotation of $\vec{V_1}$ by θ

Ans (B)

③



$W = L\cos\alpha \Rightarrow n = \frac{L}{W} = \frac{1}{\cos\alpha}$

$\cos\alpha$ is maximum at 0°. Hence for steep angles

$\cos\alpha \leq 1 \Rightarrow n > 1$

Ans (B)

④ Ans : 4 One normal stress and three shear stresses.

Ans (B)

⑤ $5\phi_{xx} + 3\phi_{xy} + 2\phi_{yy} + 9 = 0$

$B^2 - 4AC = 9 - 4(5)(2) = -31$ -ve

Hence Elliptic Ans (C)

6) Take off distance $S = \frac{W V_{T0}^2}{64 T_{t @ 0.7 V_{T0}}}$

Hence if W increases by 30%, S also increases by 30%. Ans: B)

7) Ans: D: After reaching uniform temp $\Delta T = 0 \Rightarrow \sigma, \epsilon, \tau_{xy}$

8) $V_{stall} = 40 m/s$, $\phi = 60^\circ$

$L \cos\phi = W \Rightarrow V_{stall} = \sqrt{\frac{2 W/S}{\rho C_{Lmax}}}$

$(V_{stall})_{at\ \phi = 60^\circ} = V_{stall} / \sqrt{\cos\phi} = 56.56 m/s$

Ans: C

9) Ans (C)

10) Given $\frac{dx}{dt} = -kx$

$\Rightarrow \int \frac{dx}{x} = -\int k\,dt \Rightarrow x = Ae^{-kt}$

$t = 0, x = x_0 \Rightarrow x = x_0 e^{-kt}$

At $t = 1/k \Rightarrow x = x_0/e$ Ans: C

11) Ans (A): ∵ $\frac{1}{x^2}$ is not Continuous in the interval $[-1, 1]$.

12) Ans (D)

13) Von Mises Criterion is,

$\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 = \sigma_y$

Substituting we get, $22500 + \sigma_2^2 - 150\sigma_2 = 40000$

Solving ⇒ 2.27 MPa Ans. (A)

14) $\tau = \mu \frac{du}{dy}$ For Couette flow  a st. line.

$\tau = 7 \times 10^{-3} \times \left(\frac{2-0}{1-0}\right)$

$\tau = 14 \times 10^{-3}\ N/m^2$ Ans (D)

15) $r\omega$ = Const. [For most celestial ~~rotating~~ orbiting bodies)
Angular Momentum

Ans (B)

16) Ans: (B) $\frac{\pi^2 EI}{(L/2)^2} \sim \frac{\pi^2 EI}{(0.7L)^2}$

17) It depends on the value of second Moment of area

18) Flow Separates at ~~stagnation~~ where pressure is minimum an adverse pressure gradient
$\frac{dp}{ds} = 0 \Rightarrow \quad s = \pi$ Ans (D)

19) Ans. (A)

20) Ans. (B)

21) Ans. (C) . Detailed explanation can be seen in Gas turbine theory - Cohen & Rogers.

22) Ans. (A) from Potential theory

24) Ans. (D).

25) Ans. (C)

26) $\frac{d}{dt}(mv) = 0$

$v\frac{dm}{dt} + m\frac{dv}{dt} = 0 \Rightarrow (-3.2\times10^{-8})(1.8\times10^{4}) + 100\frac{dv}{dt} = 0$

$\Rightarrow \frac{dv}{dt} = 5.76\times10^{-6}\ m/s^2$

Ans (D)

~~29)~~ x range when fuel of 50% is consumed

30) $R = \frac{\eta}{c}\left(\frac{L}{D}\right)\ln\frac{W_2}{W_1}$

$R \propto \ln\frac{W_2}{W_1}$ $\frac{R}{x} = \frac{\ln 0.8}{\ln 0.5}$

$\Rightarrow x = R\times\frac{\ln 0.5}{\ln 0.8} = 3.1R$

Ans. (B)

32)

33) $L(y_1(t)) = 2 \times \frac{s}{s^2+4} - \frac{2}{s^2+4}$ $s \to s-1$

$= 2 \times \frac{(s-1)}{(s-1)^2+4} - \frac{2}{(s-1)^2+4}$

$= 2 \times \frac{(s-2)}{(s-1)^2+4}$ [Ans. A]

$= 2 \times \frac{(s-2)}{(s-1)^2+4}$

35) $V = \sqrt{\frac{2(P_0 - P)}{\rho}} = 150\ m/s$ [Ans : B]

36) Static Margin, $\frac{\partial C_M}{\partial C_L}$ -0.1 [Ans : C]

37) ~~$2x + 2yy' = y - 2y' - 3y'$~~

Substituting various values of (x, y)

(1, 2)

(3, 0) → Max [Ans. (B)]

(6, 2)

(1, 1)

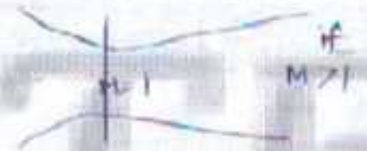
38. $L = \rho U \Gamma b$

$= 1.23 \times 100 \times 10 \times 3 = 3690N$ Ans. C)

39. $P_0 = 1.5\,MPa$, $T_0 = 2500K$, $\gamma = 1.2$, $R = 692.83$

$\frac{P_0}{P} = \left(\frac{T_0}{T}\right)^{\gamma/\gamma-1} \Rightarrow P = 0.8467\,MPa$

$\frac{T_0}{T} = 1 + \frac{\gamma - 1}{2} M^2$



$\Rightarrow T = 2272.73K$

$\therefore \rho = \frac{P}{RT} = 0.5377 \Rightarrow \dot{m} = \rho A V = 18.5\,kg/s$

Ans: (A)

41) $Q = AV \Rightarrow U = 680\,m/s$

$T_0 = T + \frac{V^2}{2C_p}$

$C_p = C_v + R = 1005, \Rightarrow 580.05 = T + \frac{680^2}{2 \times 1005}$

$\Rightarrow T = 350K$ Ans (B)

42)

4

44) Ans: (C) +0.25 radian.

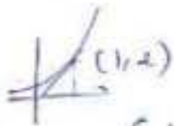
$$\frac{\partial \delta_e}{\partial C_L} = \frac{\partial \delta_e}{\partial C_M} \times \frac{\partial C_M}{\partial C_L} = \frac{1}{(-0.2)} \times (-0.1) = 0.5$$

$\partial \delta_e = 0.5(0.5)$

$= 0.5 \times 0.5$

$= 0.25$ radian

45) $y = Ax = e^x$



$x = 1 \Rightarrow y = e$ $(1, e)$ is the Common point

$\frac{dy}{dx} = e^x$ at $x = 1$ $\frac{dy}{dx} = e$ $\therefore y = ex$

Ans (D)

46) $\alpha_i = \frac{1}{4\pi U_0}\int_{-b/2}^{b/2} \frac{\frac{d\Gamma}{dy}\cdot dy}{y_0 - y} = \frac{1}{4\pi U_0}\times\frac{1}{2}\int_0^{\pi} \frac{\frac{d\Gamma}{dy}(\theta)\, d\theta}{\cos\theta - \cos\theta_0}$

$y = -\frac{b}{2}\cos\theta = -2\cos\theta$

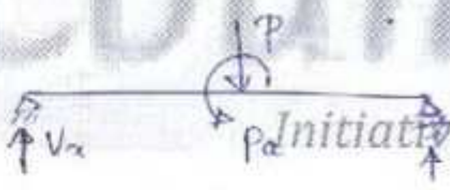
Substituting the various values and integration gives,

$\alpha_i = \frac{1}{4\pi \times 100}\times\frac{1}{2}\int_0^{\pi} \frac{100 \sin\theta\, d\theta}{\cos\theta - \cos\theta_0}$ $\qquad \frac{d\Gamma}{dy} = 100 \cos\theta \frac{d\theta}{dy}$

$= \frac{1}{8\pi}\left[\frac{\pi \sin\theta_0}{\sin\theta_0}\right] = 0.125$ radians

Ans: (A)

48) Solving for reaction forces and finding the Moment



$V_x + V_y = P$

$V_y \times L + Pa - P \times L/2 = 0 \Rightarrow V_y = P\left[\frac{1}{2} - \frac{a}{L}\right]$

$V_x = P\left[\frac{1}{2} + \frac{a}{L}\right]$

M (+ve) $\quad P\left[\frac{1}{2} + \frac{a}{L}\right]x \quad 0 < x < L/2, \quad P\left[\frac{1}{2} + \frac{a}{L}\right]x + Pa - P(x - L/2) \quad L/2 < x < L$

$P\left[\frac{1}{2}+0.1\right]x \quad 0<x<L/2$

$P\left[\frac{1}{2}+0.1\right]x - 0.1PL - P\left[x-\frac{L}{2}\right] \quad L/2 < x < L$

Ans (C)

50) $V_\theta = -2V_\infty \sin\theta - \frac{\Gamma}{2\pi R}$

$V_\theta = -75\ m/s \quad (\theta = 90^\circ)\ (V_r = 0)$ Ans. (A)

51) $C_p = 1 - \left[4\sin^2\theta + \frac{2\Gamma\sin\theta}{\pi R V_\infty} + \left(\frac{\Gamma}{2\pi R V_\infty}\right)^2\right]$

$C_p = 1 \Rightarrow$ Stagnation points,

$4\sin^2\theta$ [illegible] $\sin\theta$ [illegible]

$\sin\theta = -1/2 \Rightarrow \theta = 210^\circ \ \& \ 330^\circ$

[Ans. (A)]

1	2	3	4	5	6	7	8	9	10
A	B	B	B	C	D	D	C	C	C
11	12	13	14	15	16	17	18	19	20
A	D	A	D	B	B	D	D	A	B
21	22	23	24	25	26	27	28	29	30
C	D		D	C	D				B
31	32	33	34	35	36	37	38	39	40
		A		B	C	B	C	A	
41	42	43	44	45	46	47	48	49	50
B	C		C	D	A		C		A
51	52	53	54	55	56	57	58	59	60
A					B	A	D	C	D

61	62	63	64	65
C	C	D	B	B