தேசிய வெளிக்கள நிலையம் தொண்டைமானாறு

மூன்றாம் தவணைப் பரீட்சை - 2025

National Field Work Centre, Thondaimanaru.

3rd Term Examination - 2025

FWC

Gr : 12 (2025) **இணைந்த கணிதம்** **புள்ளித்திட்டம்**

01.

$$\frac{3x-11}{x^2-4x+3} = \frac{3x-11}{(x-1)(x-3)}$$

$$\frac{3x-11}{(x-1)(x-3)} = \frac{A}{x-1} + \frac{B}{x-3} \quad (5)$$

$$3x-11 = A(x-3)+B(x-1)$$

Comparing Coefficients of powers of x

x, $3 = A+B$

x^0, $-11 = -3A-B$

$\Rightarrow A=4,\ B=-1 \quad (5)$

$$\frac{3x-11}{(x-1)(x-3)} = \frac{4}{x-1} - \frac{1}{x-3} \quad (5)$$

Replacing x by $(x+1)$ (5)

$$\frac{3(x+1)-11}{(x+1-1)(x+1-3)} = \frac{4}{x} - \frac{1}{x-2}$$

$$\frac{3x-8}{x(x-2)} = \frac{4}{x} - \frac{1}{x-2} \quad (5)$$

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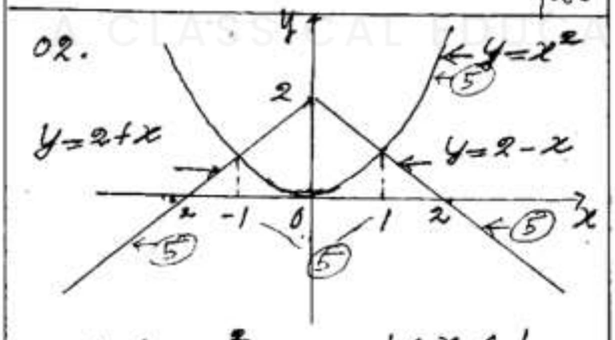
02.



$2-|x| > x^2 \Leftrightarrow -1 < x < 1$

$x \to 2x$

$2-|2x| > (2x)^2 \Leftrightarrow -1 < 2x < 1$

$1-|x| > 2x^2 \Leftrightarrow -\frac{1}{2} < x < \frac{1}{2}$

Sol^n: $-\frac{1}{2} < x < \frac{1}{2}$ (5)

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03.

$$\lim_{x\to\pi} \frac{\sqrt{3+\cos x} - \sqrt{2}}{(\pi - x)^2}$$

$$= \lim_{x\to\pi} \frac{1+\cos x}{(\pi-x)^2\{\sqrt{3+\cos x}+\sqrt{2}\}} \quad (5)$$

$$= \lim_{x\to\pi} \frac{\sin^2 x}{(\pi-x)^2\{\sqrt{3+\cos x}+\sqrt{2}\}\cdot\{1-\cos x\}}$$

$$= \lim_{x-\pi\to 0} \frac{\sin^2(\pi-x)}{(\pi-x)^2\{\sqrt{3+\cos x}+\sqrt{2}\}\{1-\cos x\}} \quad (5)$$

$$= \left\{\lim_{\pi-x\to 0} \frac{\sin(\pi-x)}{(\pi-x)}\right\}^2 \lim_{x\to\pi} \frac{1}{\{\sqrt{3+\cos x}+\sqrt{2}\}\{1-\cos x\}} \quad (5)$$

$$= 1^2 \times \frac{1}{(\sqrt{2}+\sqrt{2})} \ (5) \cdot \frac{1}{(1-(-1))} \ (5)$$

$$= \frac{1}{4\sqrt{2}} = \frac{\sqrt{2}}{8}$$

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04. $\frac{x^2}{9} - \frac{y^2}{4} = 1$ $P \equiv (3\sec\theta, 2\tan\theta)$

$$\frac{1}{9}2x - \frac{1}{4}2y\frac{dy}{dx} = 0$$

$$\frac{dy}{dx} = \frac{4x}{9y} \quad (5)$$

$$\left(\frac{dy}{dx}\right)_{(3\sec\theta,\ 2\tan\theta)} = \frac{4\times 3\sec\theta}{9\times 2\tan\theta}$$

$$= \frac{2\sec\theta}{3\tan\theta} \quad (5)$$

Equation of the tangent at P is

$$y - 2\tan\theta = \frac{2\sec\theta}{3\tan\theta}(x - 3\sec\theta) \quad (5)$$

$$3y\tan\theta - 6\tan^2\theta = 2x\sec\theta - 6\sec^2\theta$$

$$2x\sec\theta - 3y\tan\theta = 6$$

$$\frac{x}{3}\sec\theta - \frac{y}{2}\tan\theta = 1 \quad (5)$$

$(0,-2) \to \quad 0 - \frac{(-2)}{2}\tan\theta = 1$

$\theta = \frac{\pi}{4}$

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$P \equiv (3\sec\frac{\pi}{4},\ 2\tan\frac{\pi}{4}) \equiv (3\sqrt{2}, 2)$ (5)

05.

$\cos x \cos(120-x) \cos(120^\circ+x)$

$=\frac{1}{2}\cos x\{\cos 240^\circ+\cos(-2x)\}$ (5)

$=\frac{1}{2}\cos x\{-\frac{1}{2}+2\cos^2 x-1\}$ (5)

$=\frac{1}{4}\cos x\{-1+4\cos^2 x-2\}$

$=\frac{1}{4}\{4\cos^3 x-3\cos x\}$

$=\frac{1}{4}\cos 3x$ (5)

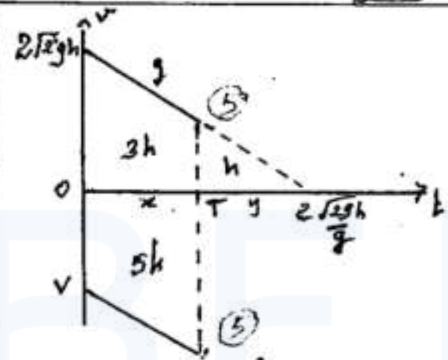
$\cos x \cos(120^\circ-x)\cos(120^\circ+x)=\frac{1}{4}\cos 3x$

put $x=20^\circ$ (5)

$\cos 20^\circ \cos 100^\circ \cos 140^\circ=\frac{1}{4}\cos 60^\circ$ (5)
$=\frac{1}{8}$

$\boxed{25}$

(6)



$\frac{4h}{h}=\frac{(x+y)^2}{y^2} \Rightarrow \frac{x+y}{y}=2$

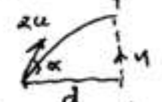
$\frac{x}{y}=1$

$\therefore T=\sqrt{\frac{2h}{g}}$ (5)

$(v+2\sqrt{2gh})T=8h$ (5)

$v=2\sqrt{2gh}$ (5)

(7)



$2u\sin\alpha=u$ (5)

$\sin\alpha=\frac{1}{2}$

$\alpha=\frac{\pi}{6}$ (5)

$\uparrow v=u+at$

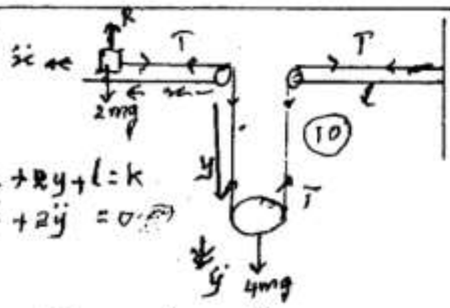
$0=u-gt$

$t=\frac{u}{g}$ (5)

$\rightarrow d=2u\cos\alpha\, t$ (5)

$=\frac{\sqrt{3}u^2}{g}$ (5)

(8)



(10)

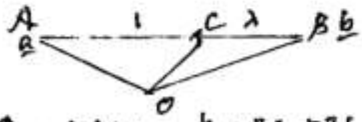
$x+2y+l=k$

$\ddot{x}+2\ddot{y}=0$ (5)

$\leftarrow -T=2m\ddot{x}$ (5)

$\downarrow 4mg-2T=4m\ddot{y}$ (5)

(9)



$\underline{a}=\underline{i}+4\underline{j}$, $\underline{b}=3\underline{i}+2\underline{j}$

$\vec{OC}=\vec{OA}+\vec{AC}$ (5)

$=\vec{OA}+\frac{1}{1+\lambda}\vec{AB}$ (5)

$=\underline{a}+\frac{1}{1+\lambda}(\underline{b}-\underline{a})$

$=\frac{\lambda}{1+\lambda}\underline{a}+\frac{1}{1+\lambda}\underline{b}$ (5) let $\frac{\lambda}{1+\lambda}=\beta$

$=\beta\underline{a}+(1-\beta)\underline{b}$ (5)

$=\beta(\underline{i}+4\underline{j})+(1-\beta)(3\underline{i}+2\underline{j})$

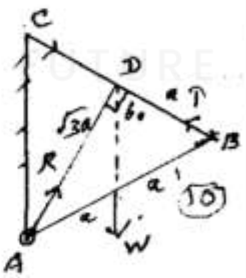
$=(3-2\beta)\underline{i}+(2\beta+2)\underline{j}$ (5)

$3-2\beta=\alpha$ let

$=\alpha\underline{i}+(5-\alpha)\underline{j}$

(10)

Δ ADC is a Triangle of Force



(10)

$AD=\sqrt{3}a$, $DC=a$

$CA=2a$

$\frac{R}{\sqrt{3}a}=\frac{T}{a}=\frac{W}{2a}$ (5)

$T=\frac{W}{2}$, (5)

$R=\frac{\sqrt{3}}{2}W$ (5)

11.

a) $x^2+x-1=0$ $\quad \alpha, \beta$

$\alpha+\beta=-1$ —(1) (5)

$\alpha\beta=-1$ —(2)

$\alpha^2+\alpha-1=0$ —(3) (5)

$\beta^2+\beta-1=0$ —(4)

$(3) \Rightarrow \alpha^2 = 1-\alpha$
$= 1-(-1-\beta)$
$= \beta+2$ (5)

$(4) \Rightarrow \beta^2 = 1-\beta$
$= 1-(-1-\alpha)$
$= \alpha+2$ (5)

$\lambda = \dfrac{\alpha+1}{\beta+1}, \mu = \dfrac{\beta+1}{\alpha+1}$ (say)

$\lambda+\mu = \dfrac{\alpha+1}{\beta+1} + \dfrac{\beta+1}{\alpha+1}$

$= \dfrac{(\alpha+1)^2+(\beta+1)^2}{(\alpha+1)(\beta+1)}$ (5)

$= \dfrac{(\alpha+\beta)^2-2\alpha\beta+2(\alpha+\beta)+2}{\alpha\beta+(\alpha+\beta)+1}$

$= \dfrac{(-1)^2-2(-1)+2(-1)+2}{-1+(-1)+1}$ (5)

$= -3$ (5)

$\lambda\mu = 1$

The required eqⁿ is

$(x-\lambda)(x-\mu)=0$ (5)

$x^2-(\lambda+\mu)x+\lambda\mu=0$

$x^2+3x+1=0$ (5) —(*)

$\boxed{45}$

$y = x+1$

$x = \dfrac{\alpha+1}{\beta+1} \Rightarrow y = \dfrac{\alpha+1}{\beta+1}+1$
$= \dfrac{\alpha+\beta+2}{\beta+1}$ (5)

$x = \dfrac{\beta+1}{\alpha+1} \Rightarrow y = \dfrac{\alpha+\beta+2}{\alpha+1}$

put $x \to y-1$ in (*)

$(y-1)^2+3(y-1)+1=0$ (5)

$y^2+y-1=0$

The eqⁿ is

$x^2+x-1=0$ (5) $\boxed{15}$

b) $x^2+ax+b=0$, $x^2+bx+a=0$ common root α (say) $(a\neq b)$

$\alpha^2+a\alpha+b=0$ —(1) (5)

$\alpha^2+b\alpha+a=0$ —(2)

$(1)-(2) \Rightarrow (a-b)\alpha+b-a=0$

$\alpha=1$ (5) $(a\neq b)$

$(1) \Rightarrow 1+a+b=0$ (5)

$2x^3-(a+b)x^2+(a+b-1)x=(a+b)^2$

$2x^3-(-1)x^2+(-1-1)x=(-1)^2$

$2x^3+x^2-2x-1=0$ (5)

$x^2(2x+1)-(2x+1)=0$

$(2x+1)(x^2-1)=0$

$(2x+1)(x-1)(x+1)=0$

$x = -\frac{1}{2}, 1, -1$ (5) $\boxed{25}$

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c) $P(x) = (x-k)^2\phi(x)$ (5)

$P'(x) = (x-k)^2\phi'(x)+\phi(x)2(x-k)$ (5)

$= (x-k)\{(x-k)\phi'(x)+2\phi(x)\}$

$= (x-k)\psi(x)$ (5)

$\therefore (x-k)$ is a factor of $P'(x)$

$\boxed{15}$

$f(x) = x^4-2x^3+5x^2+ax+b$

$f(1)=0$
$\Rightarrow 1-2+5+a+b=0$

$a+b=-4$ (5)

$f'(x) = 4x^3-6x^2+10x+a$ (5)

$f'(1)=0$

$4-6+10+a=0$ (5)

$a=-8$ (5)

$b=4$ (5)

$f(x) = x^4-2x^3+5x^2-8x+4$
$= (x-1)^2\{x^2+px+q\}$
$= (x^2-2x+1)(x^2+px+q)$

$x^3, \; -2 = p-2$ (5)

$p=0$

$x^0, \; 4=q$ (5)

$f(x) = (x-1)^2(x^2+4)$
$= (x-1)^2\{x^2-1+5\}$
$= (x-1)^2\{(x-1)(x+1)+5\}$ (5)
$= (x-1)^3(x+1)+5(x-1)^2$ (5)

reminder $= 5(x-1)^2$ (5) $\boxed{50}$

12.

a) $f(x)=\dfrac{x^2-x-2}{(x-1)^2}\ ;\ x\neq 1$

$f'(x)=\dfrac{(x-1)^2(2x-1)-(x^2-x-2)2(x-1)}{(x-1)^4}$ (15)

$=\dfrac{(x-1)(2x-1)-2(x^2-x-2)}{(x-1)^3}$

$=\dfrac{(2x^2-3x+1)-(2x^2-2x-4)}{(x-1)^3}$ (5)

$=\dfrac{5-x}{(x-1)^3}$ (5) $\boxed{25}$

$f'(x)=0 \Leftrightarrow x=5$ (5)

Range of x	$-\infty<x<1$	$1<x<5$	$5<x<\infty$
Sign of $f'(x)$	$(-)$ (5)	$(+)$ (5)	$(-)$ (5)
$f(x)$ is	Decreasing	Increasing	Decreasing

Turning point $(5, \frac{9}{8})$ is a local maximum (5)

$f(x)$ is increasing on $(1,5]$ and decreasing on $(-\infty,1)$ (5) and $[5,\infty)$ $\boxed{30}$

$f''(x)=\dfrac{2(x-7)}{(x-1)^4}$

$f''(x)=0 \Leftrightarrow x=7$ (5)

range of x	$-\infty<x<1$	$1<x<7$	$7<x<\infty$ (5)
sign of $f''(x)$	$(-)$	$(-)$ (5)	$(+)$
concavity	Concave down	Concave down	Concave up

$(7, \frac{10}{9})$ is a (5) inflection point

$x=1$ is a vertical (5) asymptote

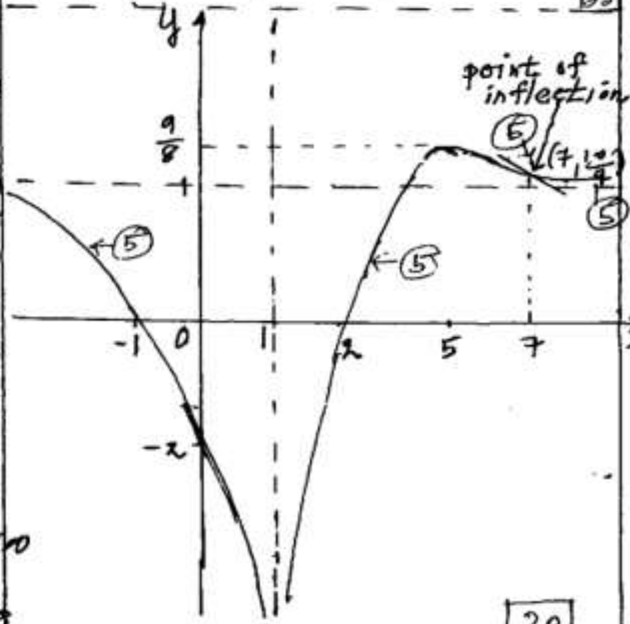
$f(x)=\dfrac{x^2-x-2}{(x-1)^2}=\dfrac{1-\frac{1}{x}-\frac{2}{x^2}}{(1-\frac{1}{x})^2}$

$x\to\pm\infty \quad f(x)\to 1$

$y=1$ is a horizontal (5) asymptote

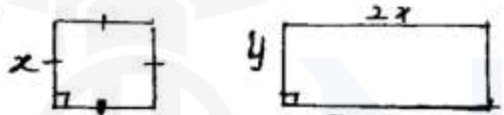
$x=0 \Rightarrow y=-2 \quad (0,-2)$ (5)

$y=0 \Rightarrow x=2,-1 \quad (2,0)\ (-1,0)$ $\boxed{35}$



$\boxed{20}$

b)



$a=4x+4x+2y$ (5)

$y=\dfrac{a-8x}{2}$ (5)

$y>0 \Rightarrow x<\dfrac{a}{8}$

$\therefore 0<x<\dfrac{a}{8}$ (5)

$A=x^2+2xy$

$=x^2+x(a-8x)$

$=ax-7x^2$ (5)

$\dfrac{dA}{dx}=a-14x$
$=-14(x-\frac{a}{14})$ (5)

$\dfrac{dA}{dx}=0 \Leftrightarrow x=\dfrac{a}{14}$ (5)

range of x	$0<x<\frac{a}{14}$	$\frac{a}{14}<x<a$
Sign of $\frac{dA}{dx}$	$(+)$	$(-)$ (5)

A is maximum when $x=\dfrac{a}{14}$ (5)

$\boxed{40}$

13.

a) $\sin(A+B) = \sin A\cos B + \cos A\sin B$ (5)

$\cos(A-B) = \sin\left\{\frac{\pi}{2} - (A-B)\right\}$ (5)

$= \sin\left\{\left(\frac{\pi}{2} - A\right) + B\right\}$

$= \sin\left(\frac{\pi}{2} - A\right)\cos B + \cos\left(\frac{\pi}{2} - A\right)\sin B$ (5)

$= \cos A\cos B + \sin A\sin B$ (5) $\boxed{20}$

$(\sin x + \cos x)(\sin 2x + \cos 2x)$

$= (\sin x\sin 2x + \cos 2x\cos x)$ (5) $+ (\sin 2x\cos x + \cos 2x\sin x)$

$= \cos x + \sin 3x$ (5) —(1) $\boxed{10}$

$(\sin x + \cos x)(\sin 2x + \cos 2x) - \cos 5x = 0$

$\cos x + \sin 3x - \cos 5x = 0$ (by (1))

$\sin 3x + 2\sin 3x\sin 2x = 0$ (5)

$\sin 3x\{1 + 2\sin 2x\} = 0$ (5)

$\sin 3x = 0$ or $1 + 2\sin 2x = 0$

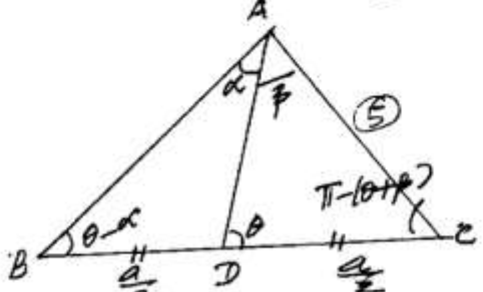
$\sin 3x = \sin 0$ $\qquad \sin 2x = \sin\left(-\frac{\pi}{6}\right)$

$3x = n_1\pi$ $\qquad 2x = n_2\pi + (-1)^{n_2}\left(-\frac{\pi}{6}\right)$

$x = \frac{n_1\pi}{3}$ (5) $\qquad x = \frac{n_2\pi}{2} + (-1)^{n_2}\left(-\frac{\pi}{12}\right)$ (5)

$n_1, n_2 \in \mathbb{Z}$ $\boxed{20}$

b) $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$ (5)



ΔABD

$\frac{AD}{\sin(\theta-\alpha)} = \frac{a/2}{\sin\alpha}$ (5)

$AD = \frac{a\sin(\theta-\alpha)}{2\sin\alpha}$ (5) —(1)

ΔADC

$\frac{AD}{\sin\{\pi-(\theta+\beta)\}} = \frac{a/2}{\sin\beta}$ (5)

$AD = \frac{a\sin(\theta+\beta)}{2\sin\beta}$ —(2) (5)

(1), (2) $\Rightarrow$

$\frac{a\sin(\theta-\alpha)}{2\sin\alpha} = \frac{a\sin(\theta+\beta)}{2\sin\beta}$ (5)

$\sin\beta\{\sin\theta\cos\alpha - \cos\theta\sin\alpha\}$
$= \sin\alpha\{\sin\theta\cos\beta + \cos\theta\sin\beta\}$ (10)

divide by $\sin\alpha\sin\beta\sin\theta$ we get

$\cot\alpha - \cot\theta = \cot\beta + \cot\theta$ (5)

$\cot\alpha - \cot\beta = 2\cot\theta$ $\boxed{50}$

c) $\tan^{-1}\left\{\frac{1}{1+x}\right\} + \tan^{-1}\left\{\frac{1}{1+2x}\right\} = \tan^{-1}\left(\frac{8}{x^2}\right)$ —(1)

$\alpha = \tan^{-1}\left\{\frac{1}{1+x}\right\}$

$\beta = \tan^{-1}\left\{\frac{1}{1+2x}\right\}$ (5) (say)

$\gamma = \tan^{-1}\left\{\frac{8}{x^2}\right\}$

(1) $\Rightarrow \alpha + \beta = \gamma$

$\tan(\alpha+\beta) = \tan\gamma$ (5)

$\frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta} = \tan\gamma$ (5)

$\frac{\frac{1}{1+x} + \frac{1}{1+2x}}{1 - \left(\frac{1}{1+x}\right)\left(\frac{1}{1+2x}\right)} = \frac{8}{x^2}$ (5)

$\frac{1+2x+1+x}{(1+x)(1+2x)-1} = \frac{8}{x^2}$ (5)

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

$3x^3 - 14x^2 - 24x = 0$ (5)

$x(3x^2 - 14x - 24) = 0$

$x(x-6)(3x+4) = 0$ (5)

put $x \to e^x$ we get (5)

$e^x(e^x - 6)(3e^x + 4) = 0$

$e^x - 6 = 0$ (5) $(\because e^x(3e^x+4) > 0)$

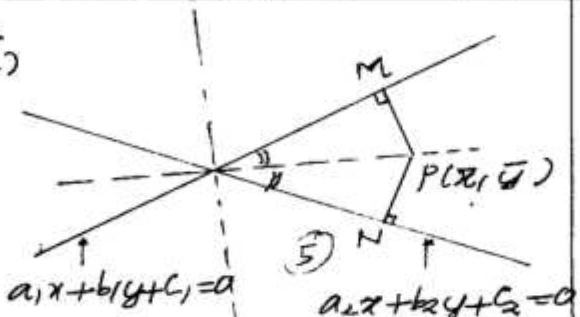
$e^x = 6$

$x = \ln 6$ (5)

$\boxed{50}$

14.

a)



(5)

Let $P(\bar{x}, \bar{y})$ be any point on one of the bisectors

$PM = PN$

$$\left|\frac{a_1\bar{x}+b_1\bar{y}+c_1}{\sqrt{a_1^2+b_1^2}}\right| = \left|\frac{a_2\bar{x}+b_2\bar{y}+c_2}{\sqrt{a_2^2+b_2^2}}\right| \quad (10)$$

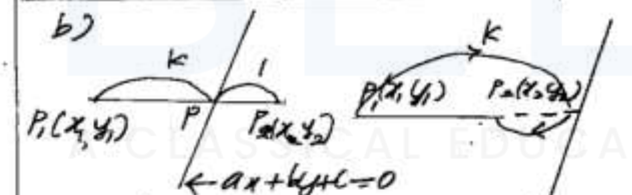
$$\frac{a_1\bar{x}+b_1\bar{y}+c_1}{\sqrt{a_1^2+b_1^2}} = \pm\left(\frac{a_2\bar{x}+b_2\bar{y}+c_2}{\sqrt{a_2^2+b_2^2}}\right) \quad (5)$$

Put $\bar{x} = x$, $\bar{y} = y$

$$\frac{a_1x+b_1y+c_1}{\sqrt{a_1^2+b_1^2}} = \pm\left(\frac{a_2x+b_2y+c_2}{\sqrt{a_2^2+b_2^2}}\right) \quad (5)$$

$\boxed{25}$

b)



$$P \equiv \left(\frac{kx_2+x_1}{k+1}, \frac{ky_2+y_1}{k+1}\right) \quad (5)$$

Since P lies on $ax+by+c=0$

$$a\left(\frac{kx_2+x_1}{k+1}\right)+b\left(\frac{ky_2+y_1}{k+1}\right)+c=0 \quad (5)$$

$$k = -\frac{(ax_1+by_1+c)}{(ax_2+by_2+c)} \quad (5)$$

If $k>0$ P_1, P_2 oposite site

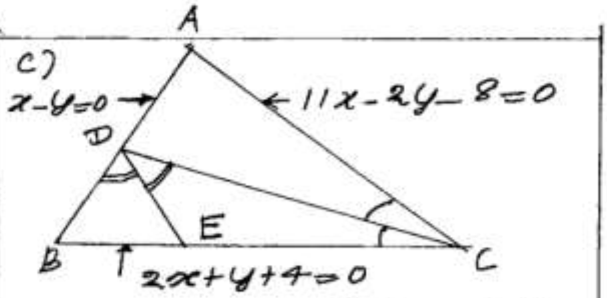
$k<0$ P_1, P_2 Same site (5)

ii) $(ax_1+by_1+c)(ax_2+by_2+c) \gtrless 0$

then P_1, P_2 same site or oposite site (5)

$\boxed{25}$

c)



$A \equiv \left(\frac{8}{9}, \frac{8}{9}\right)$ $B \equiv \left(-\frac{4}{3}, -\frac{4}{3}\right)$

$C \equiv (0, -4)$ (15)

Equation of the bisectors of the angle between lines AC, BC is

$$\frac{2x+y+4}{\sqrt{2^2+1^2}} = \pm \left(\frac{11x-2y-8}{\sqrt{11^2+(-2)^2}}\right) \quad (10)$$

$5(2x+y+4) = \pm(11x-2y-8)$ (5)

$(+) \Rightarrow x-7y-28=0$ (5)

$(-) \Rightarrow 7x+y+4=0$ (5)

Put $A\left(\frac{8}{9}, \frac{8}{9}\right)$ and $B \equiv \left(-\frac{4}{3}, -\frac{4}{3}\right)$ on $7x+y+4=0$ then

$$\left\{7\left(\frac{8}{9}\right)+\frac{8}{9}+4\right\}\left\{7\left(-\frac{4}{3}\right)-\frac{4}{3}+4\right\}<0 \quad (10)$$

$\therefore$ CD $7x+y+4=0$ (5)

$\boxed{55}$

Equation of the bisectors of the angle between lines BD, CD is

$$\frac{7x+y+4}{\sqrt{7^2+1^2}} = \pm\frac{(x-y)}{\sqrt{1^2+(-1)^2}} \quad (10)$$

$$\frac{7x+y+4}{5} = \pm(x-y) \quad (5)$$

$(+) \Rightarrow x+3y+2=0$ (5)

$(-) \Rightarrow 3x-y+1=0$ (5)

put $B \equiv \left(-\frac{4}{3}, -\frac{4}{3}\right)$, $C \equiv (0,-4)$ on $3x-y+1=0$ then

$$\left\{3\left(-\frac{4}{3}\right)+\frac{4}{3}+1\right\}\left\{0-(-4)+1\right\}<0 \quad (10)$$

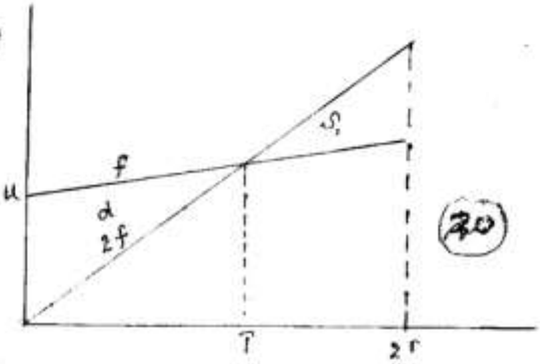
$\therefore$ DE $3x-y+1=0$ (5)

E $\left.\begin{array}{l} 3x-y+1=0 \\ 2x+y+4=0 \end{array}\right\} \Rightarrow \begin{array}{l} x=-1 \\ y=-2 \end{array}$

$E \equiv (-1, -2)$ (5)

$\boxed{45}$

(16) a)



(20)

i) $d = \frac{1}{2}uT$ (10)

ii) $u + fT = 2fT$ (10)

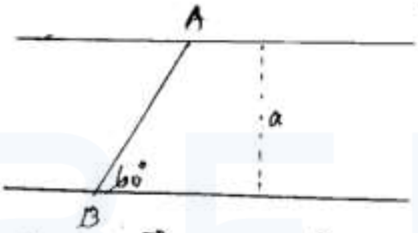
$f = \frac{u}{T}$ (5)

iii) $2f = \frac{2u}{T}$ (5)

iv) $S_1 = \frac{1}{2}uT$ (15)

[65]

b)

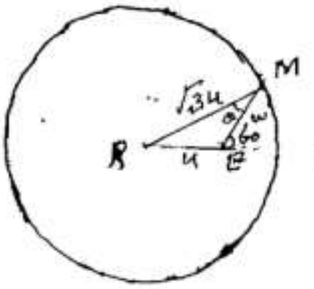


$V_{RE} = u \rightarrow$ $\quad V_{MR} = \sqrt{3}u$ (5)

V_{ME} $\angle 60$

$V_{ME} = V_{MR} + V_{RE}$ (5)

$\angle 60 \quad \sqrt{3}u \quad \rightarrow u$



(10)

Using Sin Rule

$\frac{\sqrt{3}u}{\sin 120} = \frac{u}{\sin\theta}$ (10)

$\sin\theta = \frac{1}{2}$ (5)

$\theta = \frac{\pi}{6}$ (5)

$\therefore w = \ldots$ (5)

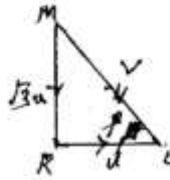
$T = \frac{a \operatorname{cosec} 60}{u}$ (5)

$= \frac{2a}{\sqrt{3}u}$ (5)

$V_{RE} \rightarrow u \quad V_{MR} \downarrow \sqrt{3}u$

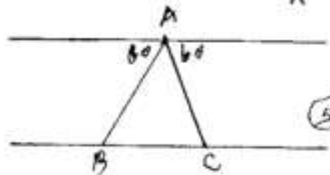
$V_{ME} = V_{MR} + V_{RE}$ (5)

$= \sqrt{3}u + u$



$\tan\beta = \sqrt{3}$, $\beta = 60$ (5)

$V = 2u$ (5)



(5)

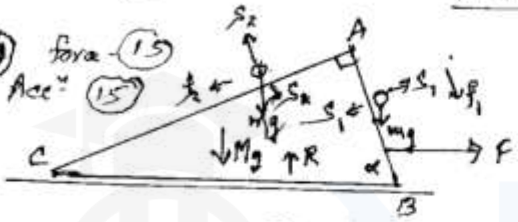
$BC = 2a \cot 60$ (5)

$= \frac{2a}{\sqrt{3}}$ (5)

[55]

(17) force (15)

Acc (15)



$\swarrow$ $mg\cos\alpha = m(f_2 - F\sin\alpha)$ (10)

$\searrow$ $mg\sin\alpha = m(f_1 + F\cos\alpha)$ (10)

$\rightarrow 0 = MF + m(F + f_1\cos\alpha) + m(F - f_2\sin\alpha)$ (15)

$= F(M+2m) + m(f_1\cos\alpha - f_2\sin\alpha)$

Solving (20)

$\Rightarrow F = 0$ (5)

$AB = a\cos\alpha, \quad AC = a\sin\alpha$

$AC - AB = a(\sin\alpha - \cos\alpha) > 0$ (5) $(\because \alpha > \frac{\pi}{4})$

$AC > AB$ (5)

Therefore mass on AB reached B first (5)

for m on AB

$S = ut + \frac{1}{2}at^2$

$a\cos\alpha = \frac{1}{2}f_1T^2$ (5)

Until the time T, wedge is on rest and $f_1 = g\sin\alpha$ (5)

$\therefore T = \sqrt{\frac{2a}{g\tan\alpha}}$

$(M+m)F = mf_2\sin\alpha$ (15)

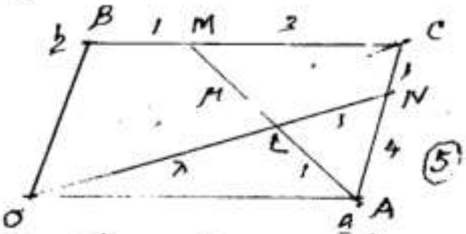
$+ \quad f_2 = g\cos\alpha + F\sin\alpha$ (10)

$F = \frac{mg\sin\alpha\cos\alpha}{M + m\cos^2\alpha}$ (10)

(17) a)

I Theory (10)

II (i)



(i) $\vec{OM} = \vec{OB} + \vec{BM}$ (5)

$= \underline{b} + \frac{1}{4}\vec{BC}$

$\underline{m} = \underline{b} + \frac{1}{4}\underline{a}$ (5)

$\vec{ON} = \vec{OA} + \vec{AN}$

$= \underline{a} + \frac{4}{5}\vec{AC}$ (5)

$\underline{n} = \underline{a} + \frac{4}{5}\underline{b}$ (5)

(ii) $\vec{AL} = \frac{1}{1+\mu}\vec{AM}$

$= \frac{1}{1+\mu}(\vec{AO} + \vec{OM})$ (5)

$= \frac{1}{1+\mu}\left[-\underline{a} + \underline{b} + \frac{1}{4}\underline{a}\right]$

$= \frac{1}{1+\mu}\left[\underline{b} - \frac{3}{4}\underline{a}\right]$ (5)

$\vec{OL} = \frac{\lambda}{\lambda+1}\vec{ON}$

$= \frac{\lambda}{\lambda+1}\left[\underline{a} + \frac{4}{5}\underline{b}\right]$ (5)

(iii) $\vec{OL} = \vec{OA} + \vec{AL}$ (5)

$\frac{\lambda}{\lambda+1}\left[\underline{a} + \frac{4}{5}\underline{b}\right] = \underline{a} + \frac{1}{1+\mu}\left[\underline{b} - \frac{3}{4}\underline{a}\right]$ (5)

$\left[\frac{\lambda}{\lambda+1} - 1 + \frac{3}{(1+\mu)4}\right]\underline{a} + \left[\frac{4\lambda}{5(\lambda+1)} - \frac{1}{1+\mu}\right]\underline{b} = 0$

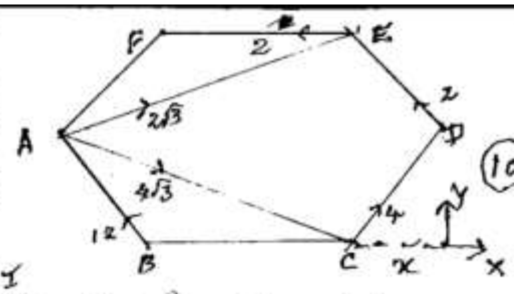
$\frac{\lambda}{\lambda+1} - 1 + \frac{3}{4(1+\mu)} = 0$

$\frac{4\lambda}{5(\lambda+1)} - \frac{1}{1+\mu} = 0$

$\mu = 1$ (5)

$\lambda = \frac{5}{3}$ (5)

[70]



(10)

I

$\rightarrow X = 4\cos 60 - 12\cos 60 - 2\cos 60 - 2 + 2\sqrt{3}\cos 30 + 4\sqrt{3}\cos 30$ (10)

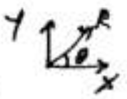
$= 2$ (5)

$\uparrow Y = 12\sin 60 + 4\sin 60 + 2\sin 60 + 2\sqrt{3}\sin 30 - 4\sqrt{3}\sin 30$ (10)

$= 8\sqrt{3}$ (5)

$R^2 = 2^2 + (8\sqrt{3})^2$

$R = 14$ (5)



II $\tan\theta = \frac{8\sqrt{3}}{2} = 4\sqrt{3}$ (5)

$\theta = \tan^{-1}(4\sqrt{3})$ (5)

(ii) C ↺

$8\sqrt{3}x = 2\cdot 4\sin 60 + 2\cdot 8\sin 60 - 2\sqrt{3}\cdot 8\cos 60\cdot\sin 60 - 12\cdot 4\sin 60$ (10)

$x = -3$ (5)

Resultant cuts BC at 1 cm from B towards C

added Couple G ↺ $= 8\sqrt{3}\cdot 3$

$= 24\sqrt{3}$ (10)

[80]