Final Exam Study Guide

MATH 172 Lab: Sections 7 and 8

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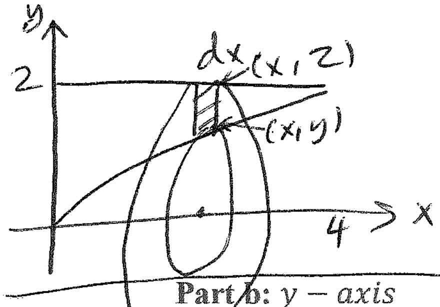
Note: This study guide contains comprehensive practice questions for the final exam in Calculus II.

Question 1: Find the volumes of the region generated by revolving $y=\sqrt{x}$, $y=2$, and $y-axis$ about the following:

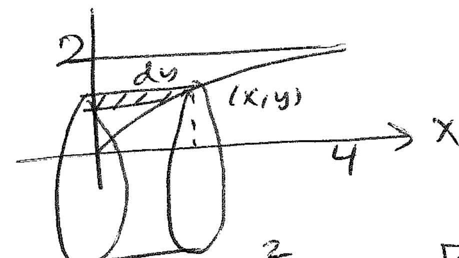
Part a: $x-axis$

Washer Method:

$$V=\int_0^4 (\pi(4)^2-\pi(y)^2)dx = \pi\int_0^4 (4-x)\,dx = \boxed{8\pi}$$



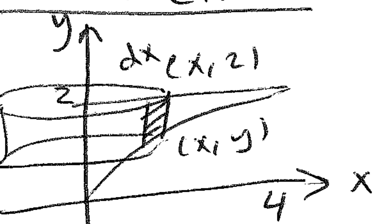
OR Shell Method



$$V=\int_0^2 2\pi y x\,dy = 2\pi\int_0^2 y\cdot y^2\,dy = \boxed{8\pi}$$

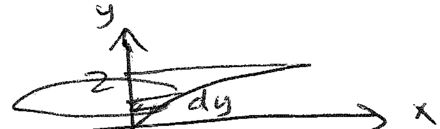
Part b: $y-axis$

Shell Method:



$$V=\int_0^4 2\pi x(2-y)\,dx = 2\pi\int_0^4 x(2-\sqrt{x})\,dx = 2\pi\int_0^4 (2x-x^{3/2})\,dx = 2\pi\left(x^2-\frac{x^{5/2}}{5/2}\right)\Big|_0^4 = 2\pi\left(\frac{16}{5}\right) = \boxed{\frac{32\pi}{5}}$$

OR Disk Method:



$$V=\int_0^2 \pi x^2\,dy = \pi\int_0^2 y^4\,dy = \pi\frac{y^5}{5}\Big|_0^2 = \boxed{\frac{32\pi}{5}}$$

Part c: $y=-1$

Shell Method

$$V=\int_0^2 2\pi(y+1)y^2\,dy$$

$$= 2\pi\int_0^2 y^3+y^2\,dy = 2\pi\left(\frac{y^4}{4}+\frac{y^3}{3}\right)\Big|_0^2 = \boxed{\frac{40}{3}\pi}$$

Question 2: Evaluate the following indefinite integrals:

Part a: $\int x^{-3}\ln(x)\,dx.$ $= \int \frac{\ln(x)}{x^3}\,dx$ by parts

$u = \ln x \qquad dv = x^{-3}\,dx$

$du = \frac{1}{x}\,dx \qquad v = \frac{x^{-2}}{-2} = \frac{-1}{2x^2}$

x^{-3}

$$\int \frac{\ln x}{x^3}\,dx = \frac{-1}{2x^2}\ln(x) + \frac{1}{2}\int\left(\frac{1}{x^3}\right)dx$$

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

$$= \boxed{\frac{-1}{2x^2}\ln(x) - \frac{1}{4x^2} + C}$$

Part b: $\int \sin^5(x)\cos^3(x)\,dx.$

$\boxed{\begin{array}{l} u = \sin(x) \\ du = \cos(x)\,dx \end{array}}$

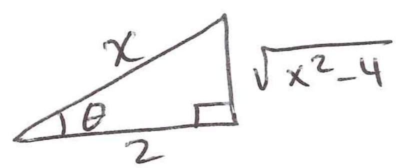
$$\int \sin^5(x)\cos^2(x)\cos(x)\,dx = \int \sin^5(x)\left(1-\sin^2(x)\right)\cos(x)\,dx$$

$\boxed{\begin{array}{l} \sin^2x + \cos^2x = 1 \\ \cos^2x = 1-\sin^2x \end{array}}$

$$\int u^5(1-u^2)\,du = \int (u^5 - u^7)\,du = \frac{u^6}{6} - \frac{u^8}{8} + C =$$

$$= \frac{\sin^6(x)}{6} - \frac{\sin^8(x)}{8} + C = \boxed{\frac{(\sin(x))^6}{6} - \frac{(\sin(x))^8}{8} + C}$$

Part c: $\int \frac{dx}{\sqrt{x^2-4}}$



$x = 2\sec\theta \implies \boxed{\sec\theta = \frac{x}{2}}$

$dx = 2\sec\theta\tan\theta\,d\theta$

$$\sqrt{x^2-4} = \sqrt{4\sec^2\theta - 4} = 2\sqrt{\sec^2\theta - 1} = 2\sqrt{\tan^2\theta} = 2\tan\theta$$

$\boxed{\begin{array}{l} 1+\tan^2\theta = \sec^2\theta \\ \sec^2\theta - 1 = \tan^2\theta \end{array}}$

$$\int \frac{\cancel{2}\sec\theta\,\cancel{\tan\theta}}{\cancel{2}\cancel{\tan\theta}}\,d\theta = \int \sec\theta\,d\theta$$

$$= \ln|\sec\theta + \tan\theta| + C$$

$$= \boxed{\ln\left|\frac{x}{2} + \frac{\sqrt{x^2-4}}{2}\right| + C}$$

Part d: $\int \tan^{-1}(\sqrt{x})\,dx$.

Let $u=\sqrt{x} \Rightarrow u^2 = x \Rightarrow \boxed{2u\,du = dx}$

$\int \tan^{-1}(u)\,2u\,du = 2\int u\tan^{-1}(u)\,du$ by parts

$\int x\tan^{-1}x\,dx$ $\quad u=\tan^{-1}x \quad dv = x\,dx$

$du = \frac{1}{1+x^2}dx \quad v = x^2/2$

add 1 subtract 1

$$\int x\tan^{-1}x\,dx = \frac{1}{2}x^2\tan^{-1}x - \frac{1}{2}\int\frac{x^2+1-1}{1+x^2} = \frac{1}{2}x^2\tan^{-1}(x) - \frac{1}{2}\int\left(\left[\frac{x^2+1}{x^2+1}\right]-\left[\frac{1}{1+x^2}\right]\right)dx$$

$$= \frac{1}{2}x^2\tan^{-1}x - \frac{1}{2}\int dx + \frac{1}{2}\int\frac{1}{1+x^2}dx = \frac{1}{2}x^2\tan^{-1}x - \frac{1}{2}x + \frac{1}{2}\tan^{-1}x + C$$

$$\Rightarrow 2\int u\tan^{-1}u\,du = u^2\tan^{-1}u - u + \tan^{-1}u + C$$

$$\Rightarrow \boxed{\int\tan^{-1}(\sqrt{x})\,dx = x\tan^{-1}(\sqrt{x}) - \sqrt{x} + \tan^{-1}(\sqrt{x}) + C}$$

■

Part e: $\int\frac{x+2}{x^3+x}dx$.

$\to x(x^2+1)$

$$\frac{x+2}{x^3+x} = \frac{A}{x} + \frac{Bx+C}{x^2+1} \Rightarrow \frac{x+2}{x^3+x} = \frac{A(x^2+1)+(Bx+C)(x)}{x(x^2+1)}$$

$x+2 = A(x^2+1)+(Bx+C)(x)$

$\underline{x=0}$: $2=A \Rightarrow \boxed{A=2}$

$\underline{x=1}$: $3 = 2A+B+C$

$\underline{x=-1}$: $1 = 2A + (-B+C)(-1)$

$1 = 2A + (B-C)$

$1 = 2A + B - C$

$3 = 2A + B + \cancel{C}$

$1 = 2A + B - \cancel{C}$

$4 = 4A + 2B$

By substituting $A=2$ in $\boxed{4=4A+2B}$

$4 = 8 + 2B \Rightarrow 4-8 = 2B \Rightarrow -4 = 2B$

$\Rightarrow \boxed{B=-2}$

$3 = 2(2)+(-2)+C \Rightarrow 3 = 4-2+C$

$\Rightarrow 3-4+2 = C \Rightarrow \boxed{C=1}$

So, $\int\frac{x+2}{x^3+x}dx = \int\left[\frac{2}{x} + \frac{-2x+1}{x^2+1}\right]dx =$

$\int\left[\frac{2}{x} - \frac{2x}{x^2+1} + \frac{1}{x^2+1}\right]dx = \boxed{2\ln|x| - \ln|x^2+1| + \tan^{-1}(x) + C}$

■

Question 3: Evaluate the following definite integral:

$$\int_3^4 \frac{dx}{x^2 - 6x + 10}$$ by completing the square

$$x^2 - 6x + 10 = \left[\underbrace{x^2 - 6x + \boxed{9}} + 10 - \boxed{9}\right] = \left[(x-3)^2 + 1\right]$$

$$\boxed{\begin{aligned} u &= x - 3 \\ du &= dx \end{aligned}}$$

$$\int_3^4 \frac{dx}{[(x-3)^2+1]} = \int_0^1 \frac{du}{u^2+1} = \tan^{-1}(u)\Big|_0^1 =$$

- when $x = 4 \to u = 4 - 3 = 1$
  $\Rightarrow \boxed{u = 1}$
- when $x = 3 \to u = 3 - 3 = 0$
  $\Rightarrow \boxed{u = 0}$

$$= \tan^{-1}(1) - \tan^{-1}(0) = \frac{\pi}{4} - 0 = \boxed{\frac{\pi}{4}}$$

☒

Question 4: Write out the partial fraction decomposition of the following expression. **DO NOT SOLVE FOR COEFFECIENTS**:

$$\frac{x^3 + 2x^2 - x + 1}{x(x^2 - 4)(x^2 + 6)^2}$$

$$\frac{x^3 + 2x^2 - x + 1}{x(x^2-4)(x^2+6)^2} = \frac{x^3 + 2x^2 - x + 1}{x(x-2)(x+2)(x^2+6)^2}$$

$$= \frac{A}{x} + \frac{B}{(x-2)} + \frac{C}{(x+2)} + \frac{Dx+E}{(x^2+6)} + \frac{Fx+G}{(x^2+6)^2}$$

☒

Question 5: Evaluate the following improper integrals and determine whether the integral converges or diverges:

Part a:

$$\int_1^\infty \frac{e^{-x^3}}{x^{-2}}\,dx = \int_1^\infty x^2 e^{-x^3}\,dx$$

$$\lim_{t\to\infty} \boxed{\int_1^t x^2 e^{-x^3}\,dx}$$

By substitution

$$\int_1^t x^2 e^{-x^3}\,dx$$

$u = -x^3$

$du = -3\boxed{x^2\,dx}$

$\frac{du}{-3} = \boxed{x^2\,dx}$

$= \frac{-1}{3}\int e^u\,du = \frac{-1}{3}e^u + C$

$= \frac{-1}{3}e^{-x^3}\Big|_1^t$

$$\lim_{t\to\infty}\left[\cancelto{0}{\frac{-1}{3}e^{-t^3}} + \frac{1}{3}e^{-1}\right]$$

$$= \frac{1}{3}e^{-1} = \frac{1}{3e} \approx 0.1226 \approx 0.12$$

$\boxed{\text{Converges}}$

Part b:

$$\int_{-1}^{8} x^{-3}\,dx = \int_{-1}^{8}\frac{1}{x^3}\,dx$$

$$\int \frac{1}{x^3}\,dx = \int x^{-3}\,dx$$

$$= \frac{x^{-2}}{-2} + C$$

$$= \boxed{\frac{-1}{2x^2} + C}$$

$$\int_{-1}^{8}\frac{1}{x^3}\,dx = \int_{-1}^{0}\frac{1}{x^3}\,dx + \int_{0}^{8}\frac{1}{x^3}\,dx$$

$$= \lim_{t\to 0^-}\int_{-1}^{t}\frac{1}{x^3}\,dx + \lim_{t\to 0^+}\int_{t}^{8}\frac{1}{x^3}\,dx$$

$$= \lim_{t\to 0^-}\left[\cancelto{-\infty}{\frac{-1}{2t^2}} + \frac{1}{2}\right] + \lim_{t\to 0^+}\left[\frac{-1}{2(64)} + \cancelto{\infty}{\frac{1}{2t^2}}\right]$$

$$= (-\infty + 1/2) + (-1/128 + \infty)$$

$$= -\infty + \infty \quad \boxed{\text{Diverges}}$$

Question 6:

Part a: Consider the following sequence $\left\{\frac{k^2-1}{k+k^2}\right\}_{k=2}^{\infty}$. Show that the sequence is increasing and determine whether the sequence is bounded above, and bounded below.

$$f(x) = \frac{x^2-1}{x+x^2} \Rightarrow f'(x) = \frac{(2x)(x+x^2) - (x^2-1)(1+2x)}{(x+x^2)^2}$$

$$f'(x) = \frac{2x^2+2x^3-[x^2+2x^3-1-2x]}{(x+x^2)^2}$$

$$f'(x) = \frac{2x^2+2x^3-x^3-2x^3+1+2x}{(x+x^2)^2} = \frac{x^2+2x+1}{(x+x^2)^2} > 0$$

So, it's increasing $(a_{k+1} > a_k)$ for $x \geq 1$

$$\boxed{\frac{1}{2} \leq a_n = \frac{k^2-1}{k+k^2} \leq 1}$$

Bounded below Bounded above

So, it's bounded

$$\lim_{k\to\infty} \frac{k^2-1}{k+k^2} = \frac{\cancel{k^2}}{\cancel{k^2}} = \boxed{1}$$

Part b: Consider the following sequence $\left\{\frac{3^k}{(2k-1)!}\right\}_{k=1}^{\infty}$. Determine whether the sequence is increasing or decreasing or neither.

$$a_k = \frac{3^k}{(2k-1)!}$$

$$\frac{a_{k+1}}{a_k} = \frac{\cancel{3^{k+1}}^{\,3}}{\cancel{(2k+1)!}_{(2k+1)(2k)}} \cdot \frac{\cancel{(2k-1)!}}{\cancel{3^k}} = \frac{3}{(2k+1)(2k)} < 1 \text{ for } k \geq 1$$

So, it's decreasing $a_{k+1} < a_k$.

Question 7: Determine if the series diverges or converges. Be sure to explain which test you use:

$$\sum_{n=2}^{\infty} \frac{(-1)^n}{\ln(n)}$$

(i) Alternating Series

(ii) $\lim_{n\to\infty} \frac{1}{\ln(n)} = \frac{1}{\ln(\infty)} = \frac{1}{\infty} = 0$

(iii) $f(x) = \frac{1}{\ln(x)} \Rightarrow f(x) = (\ln(x))^{-1}$

$f'(x) = -(\ln(x))^{-2}\left(\frac{1}{x}\right) = \frac{-[\ln(x)]^{-2}}{x} < 0$

$\Rightarrow f'(x) = \frac{-1}{x\ln^2 x} < 0$ for $n > 2$

So, it's convergent by Alternating Series Test.

Question 8: How many terms of the following series:

$$\sum_{n=1}^{\infty} \frac{(-1)^n}{n^4}$$

are needed to approximate the sum of the series with maximum error of $(0.5)10^{-4}$?

$|Error| \leq \frac{1}{n^4} \leq (0.5)(10^{-4})$

$\frac{1}{n^4} \leq \frac{0.5}{10^4}$

$\frac{1}{(n+1)^4} \leq \frac{0.5}{10^4}$

$(n+1)^4 \geq \frac{10^4}{0.5}$

$(n+1)^4 \geq 20{,}000$

$\sqrt[4]{(n+1)^4} \geq \sqrt[4]{20{,}000}$

$n+1 \geq \sqrt[4]{20{,}000}$

$n \geq \sqrt[4]{20{,}000} - 1$

So, $n \approx 11.89 - 1$

$\boxed{n \approx 10.89}$

Question 9: Determine if the following series diverges or converges. Be sure to explain which test you use:

Part a:

$$\sum_{n=1}^{\infty} \cos\left(\frac{1}{n}\right)$$

$\lim_{n\to\infty} \cos\left(\frac{1}{n}\right) = \cos\left(\frac{1}{\infty}\right) = \cos(0) = 1 \neq 0$

So, it's divergent by Nth term test

where the series oscillates between -1 and 1.

Part b:

$$\sum_{n=1}^{\infty} \frac{n+2}{\left(n^{\frac{3}{2}}+n+1\right)(n+1)}$$

leading terms

Compare with $\sum_{n=1}^{\infty} \frac{n}{n^{5/2}} = \sum_{n=1}^{\infty} \frac{1}{n^{3/2}}$ p-series $p=3/2>1$

$\lim_{n\to\infty} \frac{n+2}{(n^{3/2}+n+1)(n+1)} \cdot \frac{n^{3/2}}{1} = \lim_{n\to\infty} \frac{\cancel{n^{5/2}}}{\cancel{n^{5/2}}} = 1 > 0$

So, the series is convergent by limit Comparison Test.

Part c:

$$\sum_{n=2}^{\infty} \frac{\ln(n)}{\left(n^{\frac{3}{2}}+1\right)}$$

$\ln(n) \leq n^{\alpha}$ where

α any positive number

$\frac{\ln(n)}{n^{3/2}+1} \leq \frac{n^{0.1}}{n^{3/2}}$

$\frac{\ln(n)}{n^{3/2}+1} \leq \frac{1}{n^{7/5}} \Rightarrow \frac{\ln(n)}{n^{3/2}+1} \leq \frac{1}{n^{1.4}}$

p-series $p=1.4>1$ So, it's convergent

by Direct Comparison Test.

Question 10: Determine the radius and interval of convergence for the following series:

$$\sum_{m=0}^{\infty} \frac{m^2}{m!}(x+1)^m$$

By using ratio test:

$$\lim_{m\to\infty}\left|\frac{(m+1)^2 \cancel{(x+1)^{m+1}}^{(x+1)}}{\cancel{(m+1)!}_{(m+1)}}\cdot\frac{\cancel{m!}}{m^2 \cancel{(x+1)^m}}\right| = \lim_{m\to\infty}|x+1|\frac{(m+1)^2}{m^2(m+1)} =$$

leading terms

$$= |x+1|\lim_{m\to\infty}\frac{(m+1)^2}{m^2(m+1)} = |x+1|\lim_{m\to\infty}\frac{m^2}{m^3} = |x+1|\cdot 0 = 0$$

0

So, $\boxed{R=\infty}$ (Radius of Convergence)

$\boxed{\text{Interval of Convergence (IC)}: (-\infty,\infty)}$

Question 11: Find the following using only Taylor's series:

$$\lim_{x\to 0}\left(\frac{\sin(x^3)-x^3}{x^9}\right)$$

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

$$\lim_{x\to 0}\left[\frac{\left(\cancel{x^3} - \frac{x^9}{3!} + \frac{x^{15}}{15!} - \cdots\right)\cancel{-x^3}}{x^9}\right] = \lim_{x\to 0}\left(\frac{-1}{3!} + \frac{x^6}{15!} - \cdots\right) =$$

$$= \boxed{\frac{-1}{6}}$$

Therefore, $\lim_{x\to 0}\left(\frac{\sin(x^3)-x^3}{x^9}\right) = \frac{-1}{6}$ ▨

Question 12:

Part a: Change to rectangular coordinates and insert a graph below your result: $r = 6\cos(\theta)$.

multiply both sides of $r = 6\cos\theta$ by r, we obtain:

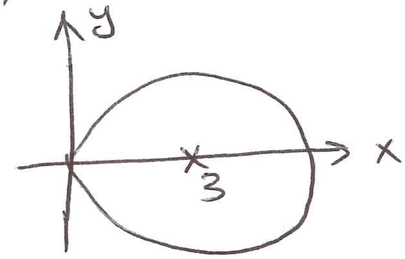
$r^2 = 6r\cos\theta$

$x^2 + y^2 = 6x$

$x^2 - 6x + y^2 = 0$ by completing the square, we have:

$\underbrace{x^2 - 6x + 9}+y^2 = 0 + 9$

$(x-3)^2 + y^2 = 9$ center $= (3,0)$, radius $= 3$



Part b: Sketch a graph for $r = 2 + 4\cos(\theta)$ using symmetry tests.

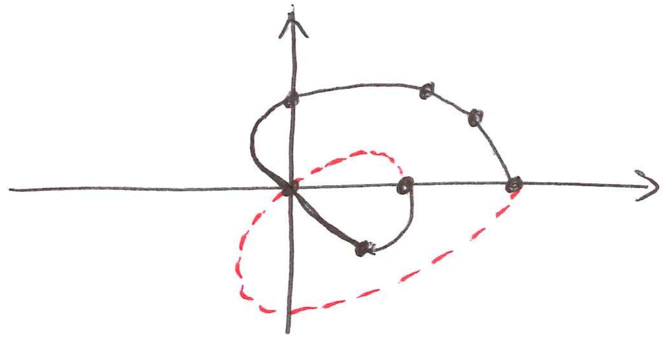
Replace (r,θ) by $(r,-\theta)$

$r = 2 + 4\cos(-\theta)$

$r = 2 + 4\cos(\theta)$

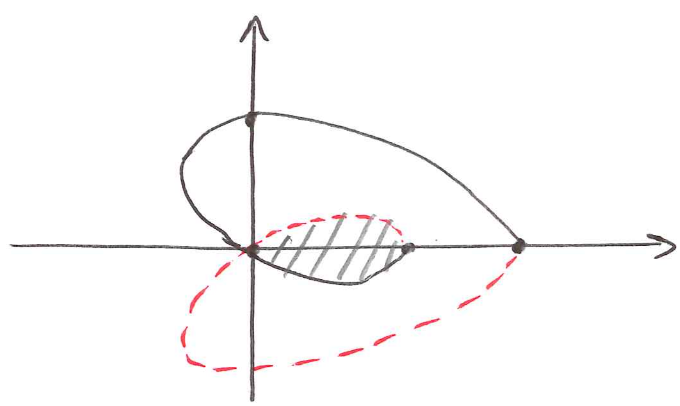
Symmetric with respect to x, r axix

r	6	4.8	4	2	0	-0.8	-2
θ	0	$\pi/4$	$\pi/3$	$\pi/2$	$2\pi/3$	$3\pi/4$	π



Part c: Find the area inside the inner loop of the polar coordinates: $r = 1 + 2\cos(\theta)$.

r	3	2	1	0	-1
θ	0	$\pi/3$	$\pi/2$	$2\pi/3$	π

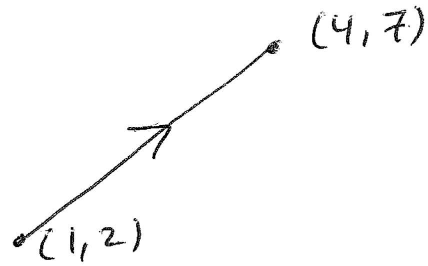


$$A = 2\left[\frac{1}{2}\int_{2\pi/3}^{\pi}(1+2\cos\theta)^2\,d\theta\right]$$

$$= \int_{2\pi/3}^{\pi}(1 + 4\cos\theta + 4\cos^2\theta)\,d\theta$$

Question 13: Find the parametric equations for the line segment joining the points (1,2) and (4,7).

$x = at + b$
$y = ct + d$



at $t = 0 \Rightarrow C(1,2)$

$\boxed{1 = b}$ $\boxed{2 = d}$

$\Downarrow$ $\Downarrow$

$\boxed{x = at + 1}$ $\boxed{y = ct + 2}$

$4 = a + 1$ $7 = C + 2$

$a + 1 = 4$ $a = 3$

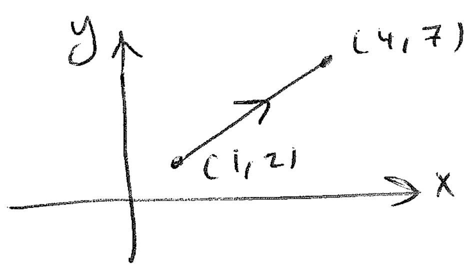
$c + 2 = 7$ $c = 5$

$\boxed{x = 3t + 1}$ $\boxed{y = 5t + 2}$

Check: $0 \leq t \leq 1$

$t = \frac{x-1}{3}$

$y = \frac{5(x-1)}{3} + 2$



Another Solution:

$x = 1 + (4-1)t$
$y = 2 + (7-2)t$

$\boxed{\begin{array}{l} x = 1 + 3t \\ y = 2 + 5t \end{array}}$ $0 \leq t \leq 1$.

Question 14:

Part a: Given $\vec{m} = \langle 2,4\rangle$ and $\vec{w} = \langle 3,1\rangle$. Find the following:

1- $\vec{m} + \vec{w}$

2- $\vec{m}$ - $2\vec{w}$

3- $\|5\vec{w} - 2\vec{m}\|$

Part 1: $\vec{m} + \vec{w} = \langle 2,4\rangle + \langle 3,1\rangle = \langle 5,5\rangle$

Part 2: $\vec{m} - 2\vec{w} = \langle 2,4\rangle - \langle 6,2\rangle = \langle -4,2\rangle$

Part 3: $5\vec{w} - 2\vec{m} = \langle 15,5\rangle - \langle 4,8\rangle = \langle 11,-3\rangle$

$$\|5\vec{w} - 2\vec{m}\| = \sqrt{11^2 + 9} = \sqrt{130} \approx 11.40$$

VA

Part b: Given $\vec{v} = \langle 6,8\rangle$. Find a unit vector $\vec{u}$ in the same direction of $\vec{v}$.

$$\vec{u} = \frac{\vec{v}}{\|\vec{v}\|} = \frac{\langle 6,8\rangle}{\sqrt{36+64}} = \frac{\langle 6,8\rangle}{\sqrt{100}} = \frac{\langle 6,8\rangle}{10} =$$

$$\vec{u} = \left\langle \frac{6}{10}, \frac{8}{10} \right\rangle$$

$$\vec{u} = \left\langle \frac{3}{5}, \frac{4}{5} \right\rangle$$ unit vector

VA

Part c: Given $\vec{m} = \langle 3,2,0 \rangle$ and $\vec{w} = \langle -2,4,3 \rangle$. Find the following:

1- $\vec{m} \cdot \vec{w}$

2- The angle θ between $\vec{m}$ and $\vec{w}$.

3- $\vec{m} \otimes \vec{w}$

Part ①: $\vec{m} \cdot \vec{w} = -6 + 8 + 0 = \boxed{2}$

Part ②: $\vec{m} \cdot \vec{w} = 2$

$\|\vec{m}\| = \sqrt{9+4+0} = \sqrt{13}$

$\|\vec{w}\| = \sqrt{4+16+9} = \sqrt{29}$

$\cos\theta = \dfrac{2}{\sqrt{13}\sqrt{29}} \Rightarrow \cos\theta = \dfrac{2}{\sqrt{377}} \Rightarrow \theta = \cos^{-1}\left(\dfrac{2}{\sqrt{377}}\right)$

$\Rightarrow \boxed{\therefore \theta \approx 84.088^\circ}$

Part ③:

$\vec{m} \times \vec{w} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & 0 \\ -2 & 4 & 3 \end{vmatrix} = \langle 6, -9, 16 \rangle$

Part d: Find the distance from the point $A(2,0,1)$ to the line joining $B(1,-2,2)$ and $C(3,0,2)$.

$\overrightarrow{BA} = \langle 1, 2, -1 \rangle$

$\overrightarrow{BC} = \langle 2, 2, 0 \rangle$

$\overrightarrow{BA} \times \overrightarrow{BC} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -1 \\ 2 & 2 & 0 \end{vmatrix} = \langle 2, -2, -2 \rangle$

$\|\overrightarrow{BA} \times \overrightarrow{BC}\| = \sqrt{4+4+4} = 2\sqrt{3}$

$\|\overrightarrow{BC}\| = \sqrt{4+4+0} = 2\sqrt{2}$

$\text{distance} = \dfrac{2\sqrt{3}}{2\sqrt{2}} = \boxed{\sqrt{3/2}}$

Good Luck in the Final Exam

Best of Luck

Mohammed K A Kaabar