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January 2021 Act 1A4000

Question one.

$$a) A = \begin{pmatrix} 8 & -1 & 7 \\ -5 & 2 & 5 \\ 3 & 0 & 2 \end{pmatrix} \quad B = \begin{pmatrix} -2 & 8 & 0.5 \\ 2 & 5 & 2 \\ 0 & -9 & 1 \end{pmatrix} \quad C = \begin{pmatrix} 25 \\ -60 \\ 112 \end{pmatrix} \quad D = \begin{pmatrix} 8 & 14 \\ 0.25 & 21 \end{pmatrix}$$

$$i) AB = \begin{pmatrix} -16 + (-2) \cdot 0 & 64 + (-5) \cdot 63 & 41 - 2 - 1 \\ 10 + 4 + 0 & -40 + 10 - 45 & -2.5 + 4 + 5 \\ -6 + 0 + 0 & 24 + 0 + 18 & 1.5 + 0 + 2 \end{pmatrix}$$

$$= \begin{pmatrix} -16 & -4 & 1 \\ 14 & -75 & 6.5 \\ -6 & 6 & 3.5 \end{pmatrix}$$

$$ii) BA = \begin{pmatrix} -16 + 40 + 1.5 & 2 + 16 + 0 & -14 + 40 + 1 \\ 16 - 25 + 6 & -2 + 10 + 0 & 14 + 25 + 4 \\ 0 + 45 + 3 & 0 - 18 + 0 & 0 + -45 + 2 \end{pmatrix}$$

$$= \begin{pmatrix} -54.5 & 18 & 27 \\ -3 & 8 & 39 \\ 48 & -18 & -43 \end{pmatrix}$$

$$iii) AC \quad \begin{matrix} r \times c & r \times c \\ 3 \times 3 & 3 \times 2 \end{matrix} \quad \begin{matrix} r \times c \\ 3 \times 2 \end{matrix}$$

$$= \begin{pmatrix} 16 + 6 + 7 & 40 + 0 + 84 \\ -10 - 12 + 5 & -25 + 0 + 60 \\ 6 + 0 + 2 & 15 + 0 + 24 \end{pmatrix} = \begin{pmatrix} 29 & 124 \\ -17 & 35 \\ 8 & 39 \end{pmatrix}$$

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iv) CA $\begin{matrix} 3 \times 2 & 3 \times 3 \\ \hline \end{matrix}$

different
 $\therefore$ cannot do.

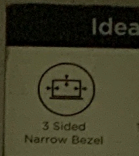
$$\begin{aligned} \text{v) } |A| &= 8(4-0) - (-1)(-10 \cdot 15) + 7(0-6) \\ &= 8(4) + 1(-25) + 7(-6) \\ &= 32 - 25 - 42 \\ &= -35 \end{aligned}$$

$$\begin{aligned} \text{vi) } |B| &= -2(5+18) - 8(2-0) + 0.5(-18-0) \\ &= -2(23) - 8(2) + 0.5(-18) \\ &= -46 - 16 - 9 \\ &= -71 \end{aligned}$$

$$\text{vii) } A+B = \begin{pmatrix} 6 & 7 & 7.5 \\ -3 & 7 & 7 \\ 3 & -9 & 3 \end{pmatrix}$$

$$\text{viii) } AB+D \quad AB = \begin{pmatrix} -18 & -4 & 1 \\ 14 & -75 & 6.5 \\ -6 & 6 & 3.5 \end{pmatrix} \quad D = \begin{pmatrix} 8 & 14 \\ 0.25 & 21 \end{pmatrix}$$

can't do because dimensions are different



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b) $15x^2 + 4x - 17 = -1$
 $x^4 = y^2$

~~$(15x^2 + 4x - 17)(15x^2 + 4x - 17)$~~

~~$225x^4$~~

$x^4 = y^2$ $\sqrt{x^4} = y$
 $x^2 = y$

$15x^2 + 4x - 17 = x^2$

$14x^2 + 4x - 17 = 0$

$$\frac{-4 \pm \sqrt{4^2 - 4(14)(-17)}}{2(14)} = \underline{\underline{x = 0.97}} \quad \text{or} \quad \underline{\underline{x = -1.25}}$$

c) $W = \begin{pmatrix} 2 & 4x & -5 \\ 2 & x & 0 \\ 1 & (x+1) & 3 \end{pmatrix}$

$|W| = 2$

$2(3x) - 4x(12) - 5(4x + 4 - x)$

$6x - 48x - 20x - 20$

$-57x - 20 = 2$

$-57x = 22$

$57x = -22$

$x = \frac{-22}{57} = \underline{\underline{-0.42}}$

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$$\begin{aligned} d) \quad 2x + 3y + 2z &= 14 \\ x + 2y + 5z &= 4 \\ 3x + y - 2z &= 19 \end{aligned}$$

$$A = \begin{pmatrix} 2 & 3 & 2 \\ 1 & 2 & 5 \\ 3 & 1 & -2 \end{pmatrix}$$

$$\begin{aligned} |A| &= 2(-4-5) - 3(-2-15) + 2(1-6) \\ &= 2(-9) - 3(-17) + 2(-5) \\ &= -18 + 51 - 10 \\ &= 23 \end{aligned}$$

$$A_1 = \begin{pmatrix} 14 & 3 & 2 \\ 4 & 2 & 5 \\ 19 & 1 & -2 \end{pmatrix}$$

$$\begin{aligned} |A_1| &= 14(-4-5) - 3(-8-95) + 2(4-38) \\ &= 14(-9) - 3(-103) + 2(-34) \\ &= 115 \end{aligned}$$

$$A_2 = \begin{pmatrix} 2 & 14 & 2 \\ 1 & 4 & 5 \\ 3 & 19 & -2 \end{pmatrix}$$

$$\begin{aligned} |A_2| &= 2(-8-95) - 14(-2-15) + 2(19-12) \\ &= 2(-103) - 14(-17) + 2(7) \\ &= 46 \end{aligned}$$

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$$A_3 = \begin{pmatrix} 2 & 3 & 14 \\ 1 & 2 & 4 \\ 3 & 1 & 19 \end{pmatrix}$$

$$|A_3| = 2(38-4) - 3(19-12) + 14(1-6) \\ = 2(34) - 3(7) + 14(-5) \\ = -23$$

$$x = \frac{|A_1|}{|A|} \quad y = \frac{|A_2|}{|A|} \quad z = \frac{|A_3|}{|A|}$$

$$x = \frac{115}{23}$$

$$y = \frac{46}{23}$$

$$z = \frac{-23}{23}$$

$$x = 5$$

$$y = 2$$

$$z = -1$$

Question two

$$Z_1 = 3+7j \quad Z_2 = 2-10j \quad Z_3 = -4-j$$

$$i) Z_1 + Z_3 = 3+7j - 4-j \\ = -1+6j$$

$$ii) Z_1 - Z_3 = 3+7j + 4+j \\ = 7+8j$$

$$iii) \frac{Z_1}{Z_2} = \frac{3+7j}{2-10j} \times \frac{2+10j}{2+10j} = \frac{(3+7j)(2+10j)}{(2-10j)(2+10j)}$$

$$= \frac{6+30j+14j+70j^2}{4+20j-20j-100j^2} = \frac{6+44j+70j^2}{4-100j^2} \quad j^2 = -1 \\ = \frac{44j-64}{104} = \frac{-64}{104} + \frac{44j}{104}$$

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$$\text{iv) } z_1 - z_2 = (3+7j) - (2+10j) \\ 3+7j - 2 - 10j \\ \underline{\underline{1-3j}}$$

$$\text{v) } (z_3)^3 - \bar{z}_1$$

$$(-4-j)^3 - (3-7j)$$

$$(-4-j)(-4-j)(-4-j) - (3-7j)$$

$$(16+4j+4j+j^2)(-4-j) - (3-7j)$$

$$(-64-16j-16j-4j^2-16j-4j^2-4j^2-j^3) - (3-7j)$$

$$(-64-48j-12j^2-j^3) - (3-7j)$$

$$-67-41j-12j^2-j^3$$

$$-67+12-j-41j$$

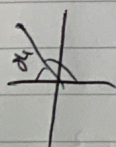
$$\underline{\underline{-55-42j}}$$

$$\text{b) } 8x^2 = -3x - 18$$

$$8x^2 + 3x + 18 = 0$$

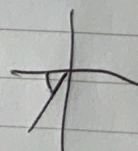
$$\frac{-(3) \pm \sqrt{3^2 - 4(8)(18)}}{2(8)}$$

$$\frac{-3 \pm \sqrt{9-576}}{16} = \frac{-3 \pm 28.81}{16}$$



$$x = \frac{-3}{16} + \frac{28.81}{16}j$$

$$\text{or } x = \frac{-3}{16} - \frac{28.81}{16}j$$



$$r = 1.81 \\ \theta = \tan^{-1}\left(\frac{\frac{28.81}{16}}{\frac{-3}{16}}\right) \\ = 95.9^\circ$$

$$r = 1.81 \\ \theta = \tan^{-1}\left(\frac{\frac{-28.81}{16}}{\frac{-3}{16}}\right) \\ = 264.91^\circ$$



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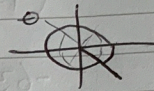
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$$1.81 (\cos(95.9) + j \sin(95.9))$$

or

$$1.81 (\cos(264.1) + j \sin(264.1))$$



c)

$$i) (3 - 10j)^6$$

$$r = \sqrt{10^2 + 3^2}$$

$$r = 10.44$$

$$\theta = \tan^{-1}\left(\frac{-10}{3}\right)$$

$$\theta = 108.79 \text{ } 286.7^\circ$$

$$10.44^6 (\cos 6 \times 286.7 + j \sin 6 \times 286.7)$$

$$ii) (-3 + 8j)^5$$

$$r = \sqrt{8^2 + 3^2}$$

$$r = 8.54$$

$$\theta = \tan^{-1}\left(\frac{8}{-3}\right)$$

$$= 110.6^\circ$$

$$8.54^5 (\cos 5 \times 110.6 + j \sin 5 \times 110.6)$$

d) 1

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e) $z_1 = 9 + 4j$ $z_2 = -7 - 5j$ $z_3 = 2 + 6j$

$\bar{z}_1 \cdot \bar{z}_2 \cdot \bar{z}_3$

$(9 - 4j)(-7 - 5j)(2 + 6j)$

$-63 - 45j + 28j + 20j^2$

$(20j^2 - 17j - 63)(2 + 6j)$

$= 40j^2 + 100j^3 - 34j - 85j^2 - 126 - 315j$

$= 100j^3 - 45j^2 - 349j - 126$

$= -100j + 45 - 349j - 126$

$= -449j - 81$

$r = \sqrt{(-449)^2 + (-81)^2}$

$= 456.25$

$\Theta = \tan^{-1}\left(\frac{-449}{-81}\right)$

$= 259.8^\circ$

$456.25(\cos 259.8^\circ + j \sin 259.8^\circ)$

f) The conjugate.