FACULTY OF SCIENCE AND ENGINEERING

ASSESSMENT COURSEWORK 2019/20

Manchester Metropolitan University

UNIT CODE: 6G4Z1102	UNIT DESC: Computer Systems Fundamentals	
ASSESSMENT ID: 2CWK25	**ASSESSMENT NAME:** coursework 25%	**WEIGHT FACTOR: 25%**

Tasks for this coursework:

- Answer all 7 questions.
- The marks awarded for each question are shown in square brackets.
- To obtain full marks **ALL** working must be shown. The report structure and presentation will also be marked.
- You must submit your coursework electronically, as pdf file, through Moodle area, assessments.
- The hand-out date is 2nd December 2019. This coursework must be completed and submitted by 24th January 2020.
- **Your mark will be scaled down by a maximum of 10% if sufficient presentation effort has not been made in your submitted coursework.**

- Tariq Jarad: office hours, Tuesday 10:00-12:00, Wednesday 10:00-11:00. **Room JD E115**
- Saeed Abuzour office hours, Tuesday 11:00-12:00, Wednesday 10:00- 11:00, Thursday 11:00-12:00. **Room JD E115**
- Frank Bierbrauer: office hours, Monday15:00-16:00, Thursday 14:00-16:00 **Room JD E114a**
- Jon Borresen: office hours, Monday 10.00-11.00, Tuesday 11.00-12.00, Wednesday 10.00-11.00. **Room JD E116**

NAME OF STAFF SETTING ASSIGNMENT: Dr Tariq Jarad & Dr Saeed AbuZour

1. Given that $U = \{1, 2, 3, ..., 10\}$ is the universal set, $A = \{x : x \in N, x \text{ is odd number}\}$ $B = \{x : x \in N, x \text{ is square number}\}$ and $C = \{x : x \in N, 2 \le x < 5\}$, find the following:

a) $|A|, |A \cap B|, |C|$; ~~{5}{4, 3}~~ {5}, {1}, {3} [4]

b) $P(B)$; {∅}, {1}, {1, 4}, {1, 9}, {4, 9}, {4}, {9}, {1, 4, 9} [3]

c) $C', B \times C, A \cap C, C \setminus B$. {1, 5, 7, 9, 1} [8]

{(1, 4), (2, 3), (1, 2), (1, 3), (2, 4)}

{3}

{2}

[15 marks for this question]

2.

a) For the universal set $U = \{1, 2, 3, ..., 36\}$, draw a Venn diagram to represent the following sets: **[6]**

$F = \{x : x \in N, x \text{ is prime number}, 0 \le x \le 15\}$; (On extra piece of paper)

$G = \{x : x \in N, x \text{ is multiple of } 3, 1 \le x \le 20\}$;

$H = \{x : x \in N, x \text{ is factor of } 36\}$.

b) Use a Venn diagram to illustrate the following: **[4]**

(i) $(A \cap B) \cap C'$; (On extra piece of Paper)

(ii) $(B \cup C) \setminus A'$.

[10 marks for this question]

3. For the three vectors $\mathbf{a} = 2\hat{i} - 3\hat{j} - \hat{k}$, $\mathbf{b} = \hat{i} - 2\hat{j} - \hat{k}$ and $\mathbf{c} = \hat{i} - \hat{j} - \hat{k}$:

a) calculate $\mathbf{a} + 2\mathbf{c}$; ~~(2, 3~~ (4, 5, 3) [3]

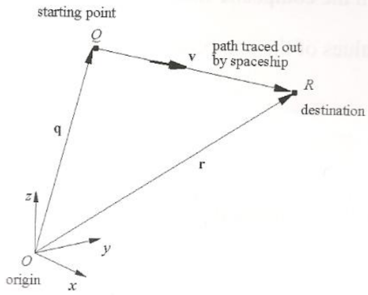
b) the unit vector in the direction of $\mathbf{c}$; $\frac{c}{\sqrt{3}}$ [3]

c) calculate $\mathbf{a} \cdot \mathbf{c}$ and find the angle between the two vectors; 0^0 [5]

d) calculate $\mathbf{a} \times \mathbf{b}$. (1, 1, −1) [4]

[15 marks for this question]

4. In a computer game, a spaceship travels on a straight line passing through the points Q, given by the position vector $\mathbf{q} = (4,-2,10)$ and P, given by the position vector $\mathbf{p} = (6,3,5)$. It arrives at its destination, the point R, after t seconds.



a) Write down the vector equation of the new position R in terms of t; **[6]**

b) Calculate the coordinates of the point R where the spaceship reaches its destination after a time of $t = 4$ seconds. **[4]**

[10 marks for this question]

5. You are given the following matrices:

$$U = \begin{pmatrix} 1 & 3 & 1 \\ 0 & 2 & -1 \\ 3 & -2 & 5 \end{pmatrix} \quad V = \begin{pmatrix} -1 & 5 & 2 \\ 0 & 3 & 1 \end{pmatrix} \quad W = \begin{pmatrix} 2 & -1 \\ 3 & 5 \end{pmatrix} \quad Z = \begin{pmatrix} 3 & -2 & 0 \\ -1 & 4 & 2 \end{pmatrix}.$$

a) Write down matrix elements $u_{31}, u_{21}, v_{32}, v_{12}, w_{22}$ and z_{33} if possible. Explain why if not possible. **[6]**

b) Calculate the following if possible and explain why if not possible:

(i) $V + W$; **[2]**

(ii) $V - Z$; **[3]**

(iii) UV^T; **[6]**

(iv) WZ. **[4]**

(all on extra piece of paper)

c) If a point (3, 1) is reflected about the line $y = (\tan\theta)x$ with $\theta = 120^\circ$, find the reflection line and the reflection point. **[4]**

reflection point (3,-4)

[25 marks for this question]

6. For the three functions $h: R \to R,\ h(x) = 2x - 1,\ \ u: R \to R,\ u(x) = \frac{x}{2} - 1$ and $v: R \to R, v(x) = x^2 + 3$, where R is the set of the real numbers:

   a) write down the composite functions $v \circ h$ and $v \circ u$; **[5]**

   b) find the values of the composite function $v \circ h$, for $x = -1, 0, 2$. **[5]**

[10 marks for this question]

7. Given the relation below, defined on $R \to R$, where R is the set of the real numbers:

$$b(x) = \frac{2(x+1)}{x-1}.$$

   a) explain when b is a function and write down the three values of $b(x)$, for $x = 0, 2, 3$, using the ordered pair representation; **[5]**

   b) if the relation is a function, state whether it is a total or partial function, and classify it as an injection, surjection, bijection or a combination of these; **[4]**

   c) find the inverse relation $b^{-1}: R \to R$ and determine the domain and the range that make the relation a function; **[4]**

   d) explain why the values $b(1)$ and $b^{-1}(2)$ are not valid for these functions. **[2]**

[15 marks for this question]

[Total:100]

1)

$A = \{1,3,5,7,9\}$

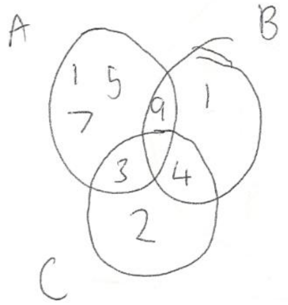
a) $|A| = \{5\}$

$A \cap B = \{1\}$

$|A \cap B| = \{1\}$

$|C| = \{3\}$

$C = \{2,3,4\}$



b) $P(B) = \{\emptyset, \{1\}, \{1,4\}, \{1,9\}, \{4,9\}, \{4\}, \{9\}, \{1,4,9\}\}$

c) $C' = \{1,5,7,9,13\}$

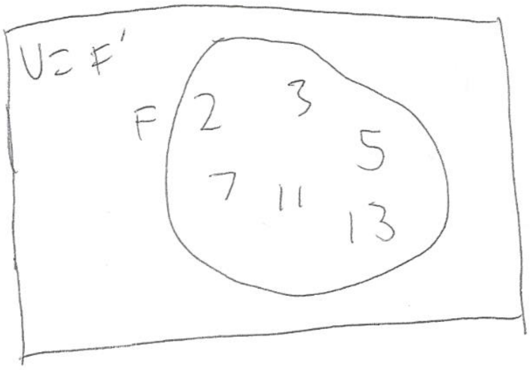
$B \times C = \{(1,4), (2,3), (1,2), (1,3), (2,4)\}$

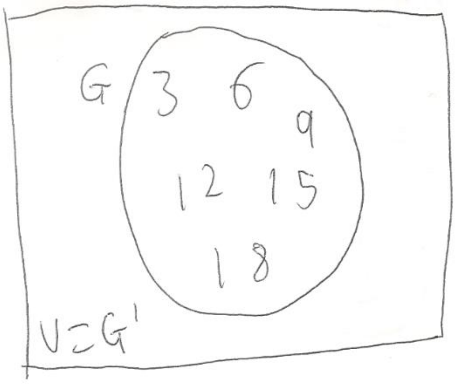
$A \cap B = \{3\}$

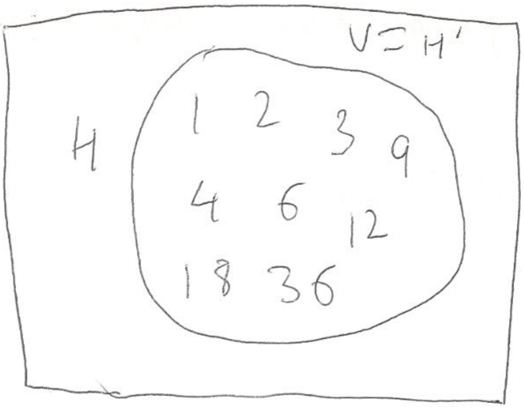
$C \setminus B = \{2\}$

2)

a)

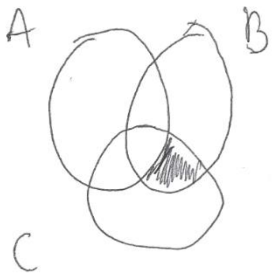




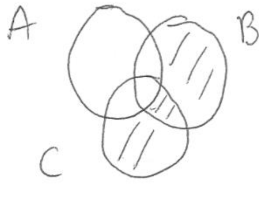


b)

i)



ii)



3)

a) $a = 2\hat{i} - 3\hat{j} - \hat{k}$

$b = \hat{i} - 2\hat{j} - \hat{k}$

$c = \hat{i} - \hat{j} - \hat{k}$

$a + 2c = (2,3,1) + 2(1,1,1) = \begin{array}{r} (2,3,1) \\ +\ (2,2,2) \\ \hline (4,5,3) \end{array}$

b) $\hat{c} = \frac{c}{\|c\|} = \frac{(1,1,1)}{\sqrt{1^2+1^2+1^2}} = \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}} = \frac{c}{\sqrt{3}}$

c) $a.b = (2i \times i), (-3j \times -j), (-k \times -k)$

$= 2 + 3 + 1 = 6$

$\|\vec{a}\| \sqrt{(2)^2, (-3)^2, (1)^2} = 6$

$\|b\| \sqrt{(1)^2, (-1)^2, (-1)^2} = 1$

$\Theta = \cos^{-1}\left(\frac{6}{6 \times 1}\right) = 0^0$

d) ~~axb (2x1) (-3x2),~~

~~axb (2 x 1), (-3x-2), (-1 x-1) = (2, 6, 1)~~

$\vec{a} \times \vec{b} = (1, 1, -1)$

$$\begin{array}{ccccc} i & j & k & i & j \\ 2 & -3 & -1 & 2 & -3 \\ 1 & -2 & -1 & 1 & -2 \end{array}$$

$\vec{a} = (2, -3, 1)$

$\vec{b} = (1, -2, -1)$

~~axb = 2i (-6, -2)~~

$a \times b = \hat{i}(-3 \times -1)\ \hat{j}(-1 \times 1)\ k(2 \times -2)$

$-\hat{i}(-1 \times -2) - \hat{j}(2 \times -1) - k(-3 \times 1)$

$= 3\hat{i} - 1\hat{j} - 4\hat{k} + 3\hat{k} - 2\hat{i} + 2\hat{j}$

$= 1i + 1j - 1k = (1, 1, -1)$

5)

a) $U_{31} = 3$, $U_{21} = 0$, $V_{32} = n/a$, $V_{12} = 0$, $W_{22} = 5$,
$Z_{33} = n/a$

bi) $v = \begin{pmatrix} -1 & 5 & 2 \\ 0 & 3 & 1 \end{pmatrix} = 3 \times 3$

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

= not possible because the number of Columns do not match

bii) $v = \begin{pmatrix} -1 & 5 & 2 \\ 0 & 3 & 1 \end{pmatrix} = 2 \times 3$

$Z = \begin{pmatrix} 3 & -2 & 0 \\ -1 & 4 & 2 \end{pmatrix} = 2 \times 3$

$= \begin{pmatrix} 4 & 7 & 2 \\ 1 & -1 & 1 \end{pmatrix}$

biii) $U = \begin{pmatrix} 1 & 3 & 1 \\ 0 & 2 & -1 \\ 3 & -2 & 5 \end{pmatrix} = 3 \times 3$

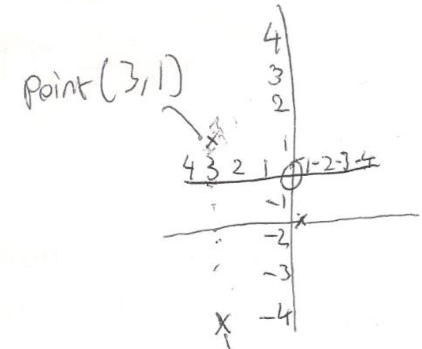
$v^T = \begin{pmatrix} -1 & 0 \\ 5 & 3 \\ 2 & 1 \end{pmatrix} = 2 \times 3$

= not possible because the number of Columns do not match

biv) $W = \begin{pmatrix} 2 & -1 \\ 3 & 5 \end{pmatrix} = 2 \times 2$

$Z = \begin{pmatrix} 3 & -2 & 0 \\ -1 & 4 & 2 \end{pmatrix} = 2 \times 3$

= not possible because the number of Columns do not match c)



$y = \tan(120)x = -1.74\ldots$

reflection point ($\frac{3}{4}$ (3, -4)

6)

a)