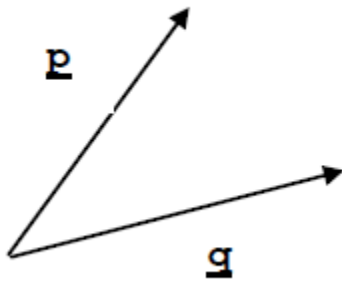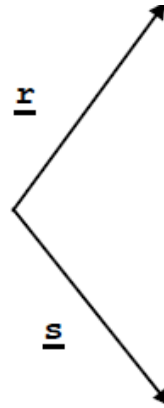# 4COSC007C Mathematics for Computing

Tutorial 9

1. Add the following vectors using the **parallelogram** or **triangle** laws:

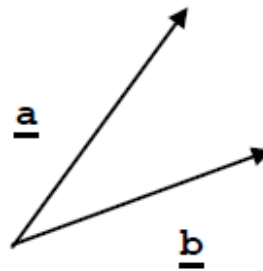(i) $\underline{p} + \underline{q}$

(ii) $\underline{r} + \underline{s}$

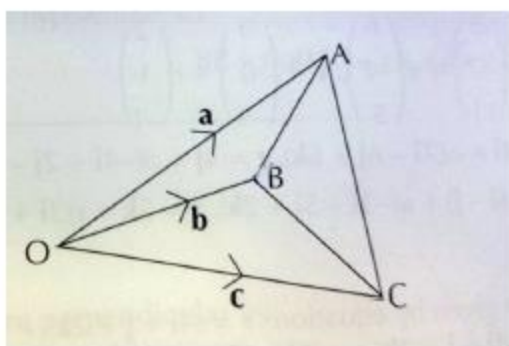2. Subtract the following vectors

(i) $\underline{a} - \underline{b}$

(ii) $\underline{c} - \underline{d}$

3. Using the Diagram, find the vectors below in terms of **a**, **b** and **c**.

a) **AB**
b) **BA**
c) **CB**
d) **AC**

4. What is the inverse of matrices **A** and **B**?

$$A = \begin{bmatrix} 1 & -2 & 0 \\ 3 & 1 & 5 \\ -1 & 2 & 3 \end{bmatrix}$$

$$B = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 2 \\ 2 & 3 & -4 \end{bmatrix}$$

5. Solve the following system of linear equations using matrices only. You will get a system of $AX = B$ and you will need to find the inverse A^{-1}.

$$7x + 2y + z = 21$$
$$3y - z = 5$$
$$-3x + 4y - 2z = -1$$

6. A triangle is defined in its local coordinate space by the following vertices:

Vertex 0: (10, -10)
Vertex 1: (-10, -10)
Vertex 2: (0, 10)

The origin is (0, 0).

The triangle is to be placed in world coordinates at the point (-20, 30). It is also to be rotated by 60 degrees anticlockwise.

(i) Create the transformation matrix by concatenating the matrices in the appropriate order.
(ii) Perform the transformations using the concatenating transformation matrix.

7. Represent the following 2D and 3D transformations in matrix notation using the homogeneous coordinates.

a. $x' = x + k_x y$
   $y' = y$

b. $x' = x$
   $y' = k_y x + y$

c. $x' = x + k_x z$
   $y' = y + k_y z$
   $z' = z$

What type of transformations are the above and in which axis are performed? Apply the first two transformations to a unit square with a shear factor of 0.5.

Challenge:

① Create a 2D object of your own. It needs to be simple so don't give **more than 5 vertices**. The origin of the object is at (0, 0).

The object is to be placed in world coordinates through a **rotation of 30 degrees** clockwise and a translation of (-10, 10).

(i) Perform the transformation matrix by concatenating the matrices in the appropriate order. Calculate the new vertices.

(ii) Scale down the object to half the size about the fixed point (-10, 10) and rotate it through 90 degrees anticlockwise about the fixed point (5, -5). Perform the transformations.

② Map the following graphs to matrices.
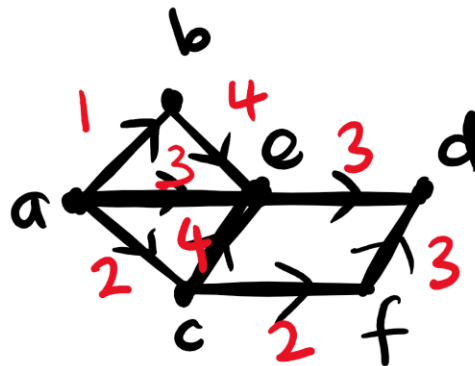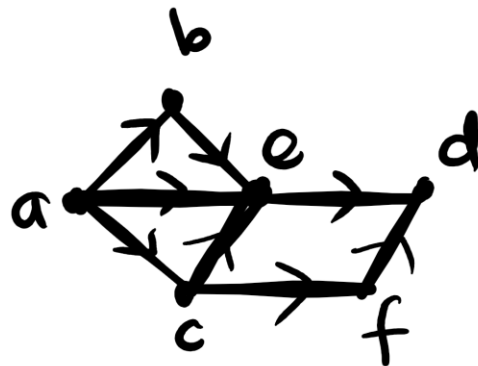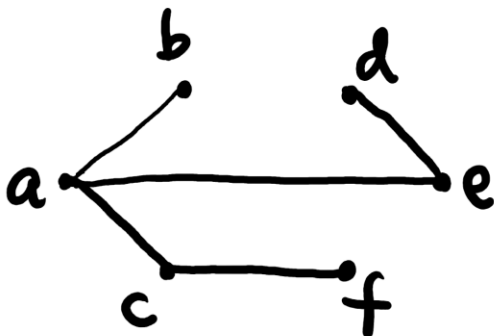
3. You are given an encoded message as: (26 -8 3)   (78 -37 16)   (41 -23 5)

Try to decode the message by using the following key (matrix K) and character map.

$$K = \begin{bmatrix} 1 & -1 & 1 \\ 2 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

a	b	c	d	e	f	g	h	i	j	k	l	m
1	2	3	4	5	6	7	8	9	10	11	12	13

n	o	p	q	r	s	t	u	v	w	x	y	z	Space
14	15	16	17	18	19	20	21	22	23	24	25	26	27