Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2016
Department of Biomedical Engineering

Math 2115
Transforms Analysis

Time: 3 hours **Full Marks: 210**

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

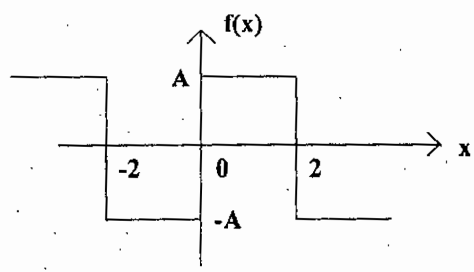
1. a) Find the Fourier series of the periodic function (15)

$$f(x)=\begin{cases}1+\dfrac{x}{\pi} & for\ -\pi\le x<0\\[2ex] 1-\dfrac{x}{\pi} & for\ 0\le x\le\pi\end{cases}$$

b) If $f(x)=\begin{cases}\pi x & for\ 0<x<1\\ \pi(2-x) & for\ 1<x<2\end{cases}$ (20)

hence develop a Fourier series of $f(x)$ for the interval (-2, 2).

2. a) Find the trigonometric Fourier series of the waveform shown in the figure: (20)



Also determine the complex Fourier series and compare the results.

b) Find the Fourier sine transform of $f(x)$, if (10)

$$f(x)=\begin{cases}x & for\ 0<x<1\\ (2-x) & for\ 1<x<2\\ 0 & for\ x>2\end{cases}$$

c) What do we understand by finite Fourier sine and cosine transforms of a function $f(x)$ defined in the interval $0<x<l$? Also write down their inverse transforms. (05)

3. a) Find the Fourier transform of (17)

$$f(x)=\begin{cases}1-x^2, & |x|<1\\ 0, & |x|>1\end{cases}$$

and hence evaluate

$$\int_0^\infty\left(\frac{x\cos x-\sin x}{x^3}\right)\cos\frac{x}{2}\,dx$$

b) If $F_c\{f(x)\}=F_c(s)=\dfrac{\sin as}{s}$ (08)

find $f(x)$ by using inverse Fourier cosine transform.

c) Find the Fourier integral of the function

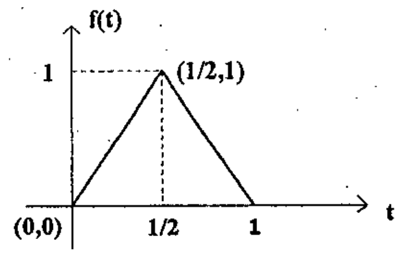
$$f(x) = e^{-kx} \text{ when } x > 0 \text{ and } f(-x) = -f(x) \text{ for } k > 0$$

and hence prove that

$$\int_0^{\infty} \frac{s\, \sin sx}{k^2 + s^2} ds = \frac{\pi}{2} e^{-kx}, k > 0$$

4. a) What is integral transform? Define Laplace transform. Find the Laplace transform of $e^{-2t}t^2 \sin 3t$ by using suitable properties. (15)

b) Find the Laplace transform of the triangular pulse as shown in the figure: (10)



c) Find the inverse Laplace transform of the following using convolution property: (10)

$$\frac{s}{(s-2)(s^2+4)}$$

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Define Z-transform and inverse Z-transform. What do we understand by region of convergence (ROC) of Z-transform? Briefly discuss important properties of ROC for the Z-transform. (13)

b) Determine the Z-transform of the signal: $x(n) = a^n \sin \omega n\, u(n)$ (09)

c) Find the inverse Z-transformation of the given function using power series expansion method for ROC $|Z| < 1$. (13)

$$X(Z) = \frac{1}{1 - 1.5Z^{-1} + 0.5Z^{-2}}$$

6. a) Define Discrete Fourier Transform. Derive the DFT of the sample data sequence $x(n) = \{1, 1, 2, 2, 3, 3\}$ and compute the corresponding amplitude and phase spectrum. (20)

b) Given $X(k) = \{20, -5.828 - 2.414j,\ 0,\ -0.172 - 0.414j,\ 0,\ -0.172 + 0.414j,\ 0,\ -5.828 + 2.414j\}$, find *x(n)*. What do we understand by Time Reversal of a sequence *x(n)*? (15)

7. a) Find the DTFT of the sequence (15)

$$x(n) = \begin{cases} \cos\frac{n\pi}{3}, & -4 \le n \le 4 \\ 0, & \text{Otherwise} \end{cases}$$

b) Given the signal $x(n) = 2^n$ and $N = 8$, find DFT *X(k)* of the signal using DITFFT algorithm. (20)

8. a) Given the signal $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$, find DFT *X(k)* of the signal using the method DIFFFT algorithm. (17)

b) Given the DFT $X(k) = \{36, -4 + 9.656j, -4 + 4j, -4 + 1.656j, -4, -4 - 1.656j, -4 - 4j, -4 - 9.656j\}$. Find the signal using IDFTFFT algorithm. (18)

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B. Sc. Engineering 2nd Year 1st Term Examination, 2016
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ECE 2115
Digital Electronics and Logic Design

Time: 3 hours **Full Marks: 210**

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What do you mean by digital signal? Draw the block diagram of a digital computer. (06)

b) What is binary logic? Find the 10's complement of $(935)_{11}$ (09)

c) Prove that (i) $x + x = x$, (ii) $x \,.\, 0 = 0$, and (iii) $x\,(x + y) = x$ (09)

d) Determine the odd parity bit generated when the message consists of the ten decimal digits in the 8, 4, –2, –1 code. (11)

2. a) Perform the following subtraction using 2's complement method and 1's complement method: (i) $(25 - 18)_{10}$, and (ii) $(101 - 1100)_2$ (10)

b) Represent the decimal number 7402 (i) in BCD, (ii) in excess-3, (iii) in $84\bar{2}\bar{1}$, and (iv) in 5211 (08)

c) Define self complementary code. Justify the statement "Excess-3 code is a self complementary code but not a weighted code." (08)

d) A seven bit Hamming code with even parity is received as (i) 1111001, (ii) 1100100, and (iii) 1110011. Locate the error position if any and find the correct message. (09)

3. a) What do you mean by universal gate? Implement the following functions using NAND, and NOR gates: $F = A + BC$ (08)

b) Simplify the following Boolean functions to a minimum number of literals: (10)
(i) $(A\bar{B}\bar{C} + A\bar{B}C + ABC + AB\bar{C})\,(A + B)$
(ii) $AB + \overline{AC} + A\bar{B}C\,(AB + C)$

c) Define Canonical form and standard form. Express the following function into Canonical form: (07)
$F = A + B'C$

d) Simplify the following Boolean functions with the help of Karnaugh's map: (10)

$$F(A,B,C,D) = \sum(0,2,3,5,6,7,8,9)$$

$$d(A,B,C,D) = \sum(10,11,12,13,14,15)$$

4. a) Define combinational logic. Design a full adder with two half adders and one OR gate. (06)

b) Implement the following function with a multiplexer: (06)

$$F(A,B,C) = \sum(1,3,5,6)$$

c) A combinational circuit is defined by the following three equations: (15)
$F_1 = x'y' + xyz'$, $F_2 = x' + y$, and $F_3 = xy + x'y'$.
Design the circuit with a PLA.

d) Design a combinational circuit using a ROM. The circuit accepts a 2-bit number and generates an output binary number equal to the multiple of 2 of the input number. (08)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is logic family? Why logic family is important in digital system design? Classify the logic family. (08)

b) Draw the circuit diagram of NAND and NOR of transistor-transistor logic (TTL) gate. (12)

c) Describe the operation of tristate output configuration of TTL gate. (15)

6. a) What are the electrical characteristics of CMOS MOSFET? Describe them with suitable diagram. (15)

b) Design a CMOS digital circuit that realizes the following Boolean functions: (10)
(i) $y_1 = a + bc$, and (ii) $y_2 = \overline{abc + d}$

c) What is Emitter-coupled logic (ECL)? Describe the operation of two input OR/NOR gate using ECL gate. (10)

7. a) What is flip-flop? Convert JK flip-flop to SR flip-flop. (10)

b) What is register? Design a 4-bit register with parallel load using D flip-flops and explain its operation. (15)

c) Design a synchronous counter that will count 15 – 10 – 9 – 8 – 7 – 6 and repeat by using JK flip-flops. (10)

8. a) Design a two bit counter to count in the sequence 00, 01, 10, 11 and repeat. Use T flip-flops. (10)

b) What is Programmable logic device (PLD)? (05)

c) Design a PLA and ROM at a gate level to realize the following sum of product functions: (20)

$$X(A,B,C) = AB + ABC + ABC'$$
$$Y(A,B,C) = AB + ABC$$
$$Z(A,B,C) = A + B$$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2016
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ME 2115
Basic Mechanics and Thermodynamics

Time: 3 hours **Full Marks: 210**

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A
(Answer **ANY THREE** questions from this section in Script A)

1. a) Determine the resultant of the three forces as shown in Fig. 1 (a), knowing that $\alpha = 40^0$. (15)

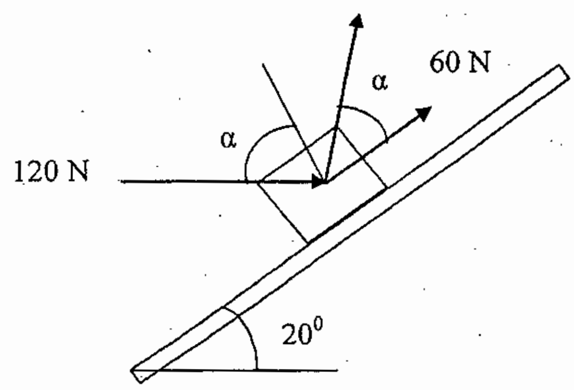

Fig. 1(a)

b) A container of weight W is suspended from ring A as shown in Fig. 1 (b). Cable BAC passes through the ring and is attached to fixed supports at B and C. Two forces $\overline{P} = P.\hat{i}$ and $\overline{Q} = Q.\hat{k}$ are applied to the ring to maintain the container in the position shown. Knowing that W=376N, determine P and Q. (20)

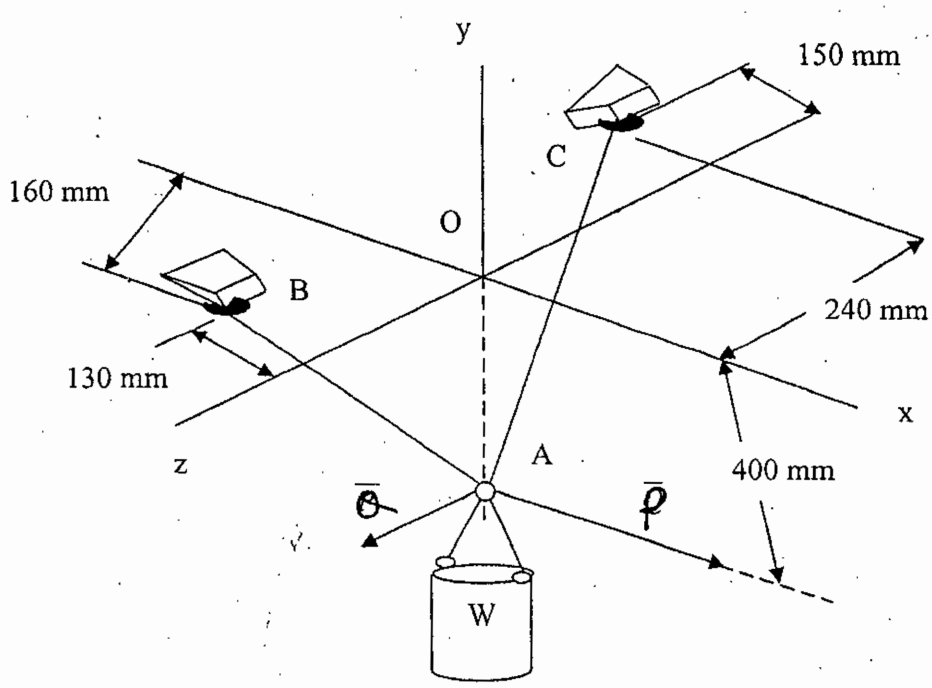

Fig. 1(b)

2. a) A cube of side 'a' is acted upon by a force P as shown in Fig. 2 (a). Determine the moment of P (i) about A, (ii) about the edge AB, (iii) about the diagonal AG of the cube, (iv) using the result of part (iii), determine the perpendicular distance between AG and FC. (20)

b) Determine the reactions at A and B shown in Fig. 2 (b) when (i) $\alpha = 0$, (ii) $\alpha = 90^0$, (iii) $\alpha = 30^0$. (15)

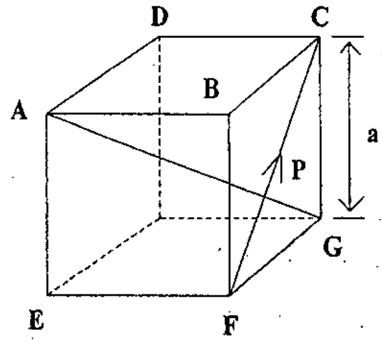

Fig. 2(a)

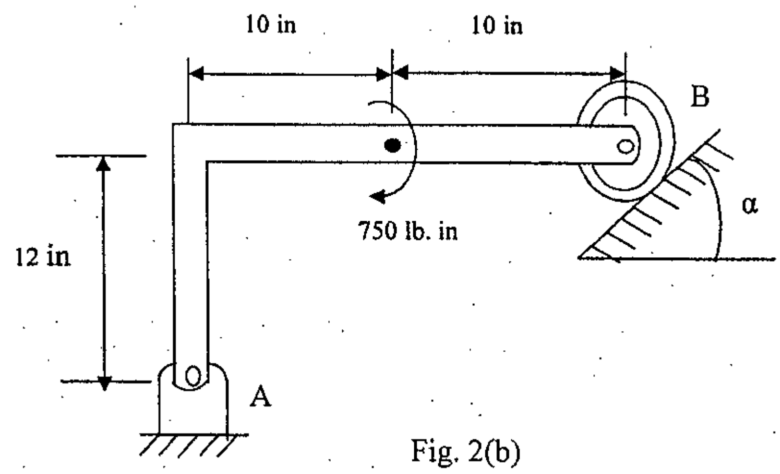

Fig. 2(b)

3. a) Define the term 'Fluid'. Distinguish between Real Fluid and Ideal Fluid. (08)

   b) State and prove Newton's law of viscosity. Why viscosity of any fluid decreases with increase of temperature? (12)

   c) Show that pressure at a point in fluid at rest or in motion is independent of direction as long as there are no shearing stresses. (15)

4. a) What is total pressure and center of pressure? Deduce the expression for total pressure on a vertical plane surface. (12)

   b) Derive Bernoulli equation for steady, inviscid flow along a streamline. (13)

   c) What is the function of manometer? Classify manometers with net sketches. (10)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) State and explain zeroth law of thermodynamics. Why this law is called the basis for temperature measurement? (10)

   b) What are the different forms of energy encountered in thermodynamics? Using the 1st law of thermodynamics deduce the expression for non-flow energy equation. (12)

   c) A closed system executes a reversible process wherein the pressure and volume vary in accordance with PV^n = constant, $Q = 16.25$ kJ, $\Delta U = 47.48$ kJ. If $P_1 = 101$ kPa, $V_1 = 141.6$ litre and $P_2 = 827.4$ kPa, find n and V_2. (13)

6. a) What are the limitations of 1st law of thermodynamics? Write down two statements for 2nd law of thermodynamics. (12)

   b) Write down the assumptions of deriving the steady flow energy equation. (08)

   c) Prove that Kelvin-Planck's statement and Clausius statement for 2nd law of thermodynamics are equivalent. (15)

7. a) Define reversible process. Why do we study reversible process? State the main causes of irreversibility. (07)

   b) What is meant by entropy? Explain how the concept of entropy can be used to identify the process that is prohibited in nature. Explain with example. (12)

   c) Why a heat engine without a condenser is a perpetual motion machine of 2nd kind (PMM2)? Explain why won't PMM2 work? (10)

   d) How heat engine and refrigerator are related with the second law of thermodynamics? (06)

8. a) Derive the three dimensional general governing equation of conduction heat transfer in solid, then deduce the equation for the special conditions: (i) steady state, (ii) transient, no heat generation, and (iii) steady state, no heat generation. (20)

   b) Consider a person standing in a breezy room at 20^0c. Determine the total rate of heat transfer from this person if the exposed surface area and the average outer surface temperature of the person are 1.6 m^2 and 29^0c, respectively, and the convection heat transfer coefficient is 6 $W/m^2.^0c$. (15)

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BME 2101
Human Anatomy

Time: 3 hours **Full Marks: 210**

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A
(Answer **ANY THREE** questions from this section in Script A)

1. a) Describe the boundary and contents of femoral triangle. (10)

   b) Gives the origin, insertion, nerve supply and action of the following muscles- (15)
   (i) Sartorious
   (ii) Biceps femoris
   (iii) Gastrocnemius

   c) Describe the anatomical features of the following bones- (10)
   (i) Femur
   (ii) Tibia

2. a) Describe the vascular system of lower limb. (10)

   b) Describe the structure and lymphatic system of breast. (15)

   c) Describe the boundary and content of popliteal fossa. (10)

3. a) Describe the area of blood supply of both left and right coronary artery. (15)

   b) Describe the conducting system of the heart. (10)

   c) What are the movements of shoulder joint? Mention the name of the muscles responsible for the movements. (10)

4. a) Describe the bronchial tree. What are the differences between right and left lung? (12)

   b) Draw and describe the function of different parts of the eye. (15)

   c) Mention the structure under cover of gluteus maximus. (08)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5.	a)	Name different planes of the body and how they divide the body.	(10)
	b)	Mention the major organs and functions of six major organ systems of the body.	(13)
	c)	Draw the diagram of a neuron with brief description of its different parts.	(12)
6.	a)	Write short note on adult human brain mentioning its feature, regions and blood supply.	(15)
	b)	Discuss about cerebellum and different types of brain waves.	(12)
	c)	Name different ascending and descending tracts of CNS.	(08)
7.	a)	Illustrate with diagram how abdominal cavity is divided for descriptive purpose.	(10)
	b)	Write short note on stomach mentioning its location, features, regions and functions.	(15)
	c)	Outline the gross features of liver, pancreas, and gall bladder.	(10)
8.	a)	Draw the diagram showing location of both kidneys in the different region of abdominal cavity.	(10)
	b)	Tabulate the different components of male genital system with their functions.	(15)
	c)	Outline the features of ureter and urinary bladder.	(10)

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BME 2151
Numerical Methods and Statistics

Time: 3 hours **Full Marks: 210**

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Chi-square (χ^2) distribution chart will be provided on request.
iii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is numerical error? Estimate the relative error in $z = x - y$ when $x = 0.3456\times10^4$ and $y = 0.3454\times10^4$ as stored in a system with four digit mantissa. (12)

b) Find a root of the equation $x^2 - 4x - 10 = 0$ using bisection method (upto 5th iteration). (12)

c) Find the root of the equation $f(x) = x^2 - 3x + 2$ in the vicinity of $x = 0$ using Newton-Raphson method. (11)

2. a) Find the Lagrange interpolation polynomial to fit the following data: (15)

i	0	1	2	3
x_i	0	1	2	3
$e^{x_i} - 1$	0	1.7183	6.3891	19.0855

Use the polynomial to estimate the value of $e^{1.5}$.

b) A table of data for $Logx$ is given below. Estimate $Log2.5$ using second order Newton interpolation polynomial. (11)

i	0	1	2	3
x_i	1	2	3	4
$Logx_i$	0	0.3010	0.4771	0.6021

c) Find the divided differences $f[x_o, x_1]$, $f[x_1, x_2]$ and $f[x_o, x_1, x_2]$ for the data given below: (09)

i	0	1	2
x_i	1.0	1.5	2.5
$f(x_i)$	3.2	3.5	4.5

3. a) Solve the following system of equations using basic Gauss elimination method: (10)

$$3x_1 + 2x_2 + x_3 = 10$$
$$2x_1 + 3x_2 + 2x_3 = 14$$
$$x_1 + 2x_2 + 3x_3 = 14$$

b) Evaluate the following integrals using Simpson's 1/3 rule: (10)

(i) $I = \int_{-1}^{1} e^x dx$ (ii) $I = \int_{0}^{\frac{\pi}{2}} \sqrt{cosx}dx$

c) Compute Romberg estimate R_{22} for $\int_1^2 \frac{1}{x} dx$ (15)

4. a) Estimate $y(2)$ by Euler's method for the following equation using $y(1) = 2$ and h = 0.5 (10)

$$\frac{dy}{dx} = x^2 + y^2$$

b) Use the classical RK method to estimate $y(0.5)$ when $y'(x) = x/y$ with $y(0) = 1$ and $h = 0.25$. (14)

c) Solve the Poisson equation $\nabla^2 f = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 \le y \le 3$ with $f = 0$ on the boundary and $h = 1$. (11)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is meant by probability? Find the probability that a single toss of a die will result in a number less than 4 if (i) no other information is given and (ii) it is given that the toss resulted in an odd number. (09)

b) Define random variables. Find the distribution function and its graph for the random variable X as shown below where a fair coin is tossed twice and X represent the number of heads that can come up. (14)

Sample point	HH	HT	TH	TT
X	2	1	1	0

c) Find the probability that in a family of 4 children there will be (i) at least 1 boy and (ii) at least 1 boy and 1 girl. Assume that the probability of a male birth is ½. (06)

d) Ten percent of the tools produced in a certain manufacturing process turn out to be defective. Find the probability that in a sample of 10 tools chosen at random exactly two will be defective by using (i) the binomial distribution and (ii) the Poisson approximation to the binomial distribution. (06)

6. a) Prove that the total area of the rectangles in a histogram is equal to the total area bounded by the corresponding frequency polygon and the x-axis. (08)

b) Use the frequency distribution of heights in the following table to find the mean, mean deviation and standard deviation of the 100 male students at XYZ university. (18)

Height (in)	Number of students
60–62	5
63–65	18
66–68	42
69–71	27
72–74	8
Total	100

c) Define standard deviation. If $d = X - A$ are the deviations of X from any arbitrary constant A, prove that: (09)

$$s = \sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2}$$

7. a) Fit a least-squares line to the data given below using X as the independent variable: (10)

X	1	3	4	6	8
Y	1	2	4	4	5

b) Fit a least-squares parabola having the form $Y = a_0 + a_1X + a_2X^2$ to the data given below: (15)

X	1.2	1.8	3.1	4.9	5.7
Y	4.5	5.9	7.0	7.8	7.2

c) Define correlation. If the regression line of Y on X is given by $Y = a_0 + a_1X$, prove that the standard error of estimate $s_{Y.X}$ is given by: (10)

$$s_{Y.X}^2 = \frac{\sum Y^2 - a_0 \sum Y - a_1 \sum XY}{N}$$

8. a) What is correlation coefficient? Find the linear correlation coefficient of the data given below: (12)

X	1	3	4	6	8	9	11	14
Y	1	2	4	4	5	7	8	9

b) Table shows the respective heights X and Y of a sample of 12 fathers and their oldest sons. Calculate the coefficient of rank correlation. (12)

Height X of father (in)	65	63	67	64	68	62	70	66	68	67	69	71
Height Y of son (in)	68	66	68	65	69	66	68	65	71	67	68	70

c) Define χ^2. Table shows the observed and expected frequencies in tossing a die 120 times. Test the hypothesis that the die is fair using a significance level of 0.05. (11)

Event	1	2	3	4	5	6
Observed frequency	25	17	15	23	24	16
Expected frequency	20	20	20	20	20	20