

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 3rd Year 1st Term Examination, 2023

M E 3131

(Fluid Mechanics and Machinery)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

iii) Assume reasonable data if any missing.

SECTION-A

- 1(a) What is meant by viscosity and surface tension? Explain why and show that pressure jump due to the surface tension in soap bubble is double than that of liquid droplet. 12
- 1(b) Explain the terms: (i) Ideal fluid, (ii) Real fluid, (iii) Newtonian fluid and (iv) Non-Newtonian fluid. 12
- 1(c) A plate 0.0254 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 0.2 kg(f)/m² to maintain this speed. Determine the dynamic viscosity of the fluid between the plates [SG=0.90] 11
- 2(a) Differentiate between simple and differential manometers. 08
- 2(b) Show that the rate of increase of pressure in a vertical direction is equal to weight density of the fluid at that point. 12
- 2(c) The pressure difference between oil pipe and water pipe is measured by a differential U-tube manometer, as shown in figure 2(c). For the given fluid heights and specific gravities, find the pressure difference between A and B. 15

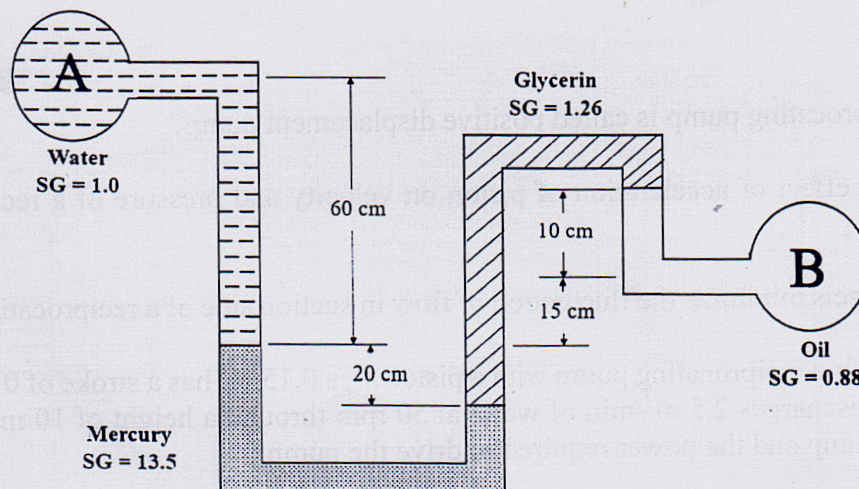


Figure 2(c)

- 3(a) Define total pressure and center of pressure. 08
- 3(b) Derive an expression for the center of pressure on an inclined submerged plane surface. 12
- 3(c) Find the magnitude and direction of the resultant force due to water acting on a roller gate of cylinder shape of diameter 4 m. Consider the gate is placed down in such a way that the water is going to spill. Take the length of the gate is 18 m. 15

- 4(a) What is metacenter? How metacentric height is the measure of stability for floating body? Demonstrate the stable and unstable configuration with neat sketch. 10
- 4(b) Explain the relationship among the momentum equations, Navier-Stokes equations, Euler's equations and Bernoulli's equation. 10
- 4(c) A cylinder buoy is 2m in diameter and 2.5 m long with weight 2.2 metric tons. The density of the sea water is 1025 kg/m^3 . Show that the buoy does not float with its axis vertically. 15

SECTION-B

- 5(a) Sketch the casing of a centrifugal pump and explain its role to increase the pressure energy. 08
- 5(b) Explain the characteristics curves for a centrifugal pump. 12
- 5(c) A turbine is to operate under a head of 25 m at 200 rpm. The discharge is $9 \text{ m}^3/\text{s}$. If the efficiency is 90%, determine: 15
- i) Specific speed of the turbine
 - ii) Power generated and
 - iii) Type of turbine.
- 6(a) Write short notes on: (i) Orifice meter, (ii) Notch, and (iii) Weir 09
- 6(b) How a pitot tube is used to measure the velocity of flow through a pipe? 05
- 6(c) Derive the expression of flow rate when fluid is flowing over a triangular notch. 10
- 6(d) A triangular notch is applied to measure the flow rate through a canal whose maximum capacity is $1.4 \text{ m}^3/\text{sec}$. for a flow rate of 6 liter/s, the depth of water over the notch becomes 0.15 m. Determine the top width and depth of the notch assuming $C_d=0.85$. 11
- 7(a) Why a reciprocating pump is called positive displacement pump? 05
- 7(b) Discuss the effect of acceleration of piston on velocity and pressure of a reciprocating pump. 10
- 7(c) How air vessels minimize the fluctuation of flow in suction side of a reciprocating pump? 07
- 7(d) A double acting reciprocating pump with a piston area 0.15 m^2 has a stroke of 0.3 m long. The pump discharges $2.5 \text{ m}^3/\text{min}$ of water at 50 rpm through a height of 10 m. Find the slip of the pump and the power required to drive the pump. 13
- 8(a) Define the terms specific speed, unit speed and unit power as applied to hydraulic turbines. 08
- 8(b) Why draft tube is used in a turbine? Derive the expression of efficiency for a draft tube. 12
- 8(c) A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 liters/s under a head of 30 m. The buckets deflect the jet through an angle of 160° . Calculate the power given by the water to the runner and hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98. 15

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 3rd Year 1st Term Examination, 2023

MTE 3103

(Microprocessor, Microcontroller and Interfacing)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

iii) Assume reasonable data if any missing.

SECTION-A

- 1(a) Write down the working principle of crystal clock circuit for 3.6 GHz Intel Quad Core microprocessor. 10
- 1(b) Draw the internal architecture for 8086 microprocessor. What are the key differences between 8085 and 8086 microprocessor? 08
- 1(c) Illustrate the significance of instruction Queue for pipelined Hex-code fetch and execution in 8086 microprocessor system. 07
- 1(d) Draw a bit pattern of flag register in Intel 8086 microprocessor and write down the function of each flag bit in brief. 10
- 2(a) Demonstrate the significance of odd and even memory banks for accessing a data byte in 8086-based microprocessor system. 08
- 2(b) Discuss the functions of segment registers and index registers in 8086 microprocessor. 09
- 2(c) Write down the applications of following common-mode Signal pins in 8086 microprocessor. 10
- i) Ready (Pin 22)
 - ii) $\overline{\text{TEST}}$ (Pin 23)
 - iii) $\overline{\text{INTA}}$ (Pin 24)
 - iv) INTR (Pin18)
 - v) RESET (Pin 21)
- 2(d) What is meant by direct memory access (DMA) data transfer? Briefly describe DMA data transfer process with relevant figure. 08
- 3(a) Define maximum code operation in 8086 microprocessor. Clarify the basic idea behind closely-coupled configuration of multiprocessor mode. 10
- 3(b) Write down the names of maximum mode signal pins in 8086 microprocessor with their specific bus status codes and corresponding CPU cycles. 09
- 3(c) Give some examples of software interrupts in 8086 microprocessor system with their unique interpretations. 05
- 3(d) How host processor communicates with guest processor in maximum mode interface? Explain by means of 8288 bus controller. Use relevant block diagrams. 11
- 4(a) Specify the contents of the registers (A, B) and the flag status (S, Z, CY) as the following instructions are executed. 08
- | | |
|-----|--------|
| MVI | A, F8H |
| SUB | A |
| MOV | B, A |
| DCR | B |
| INR | B |
| SUI | 01H |
| HLT | |
- 4(b) Compare Intel Pentium microprocessors in terms of transistors, CPU speed and Data length. 08

- 4(c) Elaborate the functions of following Arithmetic operations in 8085 microprocessor.
 i) ACI 35H
 ii) LXI BC, 35H
 iii) SBB C
 iv) DAA
 v) DCX BC
- 4(d) Discuss the concept of Tri-state logic and WAIT state in microprocessors. 09

SECTION-B

- 5(a) What is duty cycle? Why do we put a driver between the microcontroller and the DC motor? 07
- 5(b) Write down the difference between the wave generated by phase-correct PWM and fast PWM. 08
- 5(c) You are designing a LFR using AVR microcontroller. The robot needs to store its calibration settings (such as sensor thresholds and motor speeds) in EEPROM so that these settings are retained even after the robot is power off. 20
 (i) Write a code to save the sensor threshold value and motor speed value to EEPROM.
 (ii) Write a code to read the saved sensor threshold value and motor speed value from EEPROM and use them to initialize the robot settings.
- 6(a) What is the drawback of using RAM data space for fixed data? 05
- 6(b) Write a AVR C program that 15
 i) After 4 external clocks turns on an LED connected to the OC0 pin, and
 ii) Toggles the OC0 pin every 4 pulses.
- 6(c) Give some factors that can affect time delay in AVR microcontroller. 08
- 6(d) List the timers of ATmega 32 and their associated registers. 07
- 7(a) List the advantages of serial communication over parallel. 08
- 7(b) You are tasked with designing a data logging system using an AVR microcontroller. The system needs to measure and store temperature readings whenever an external interrupt occurs. To achieve this, you need to configure the external interrupt and store the readings in the EEPROM for non-volatile storage. Now write the AVR C program for this task. 20
- 7(c) List some of the interrupt sources in the AVR. 07
- 8(a) Write an AVR C program to transmit serially the message "The earth is but one country and mankind its citizens" continuously at 57600 baud rates. 10
- 8(b) In the following figure, a switch (SW) is connected to PB0. Using Timer 0 and non-inverting phase correct PWM mode, write an AVR C program that generates a wave with frequency of 978 Hz. When SW is closed, the duty cycle is 20% and when it is open, the duty cycle is 85%. XTAL=8MHz. 15

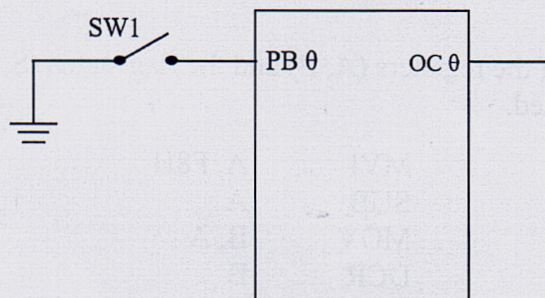


Figure 8(b)

- 8(c) Write an AVR C program to monitor bit 5 of PORTC. If it is 1, make bit 4 of PORTC input; otherwise, change bit 4 of PORTC to output. 10

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B. Sc. Engineering 3rd Year 1st Term Examination, 2023

MTE 3105

(Linear Integrated Circuit and Digital Systems)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if any missing.

SECTION-A

- 1(a) Draw the pin diagram of NE 555 timer IC. Discuss its operation in astable multivibrator mode. Find the duty cycle of an astable multivibrator if $R_1=1M\Omega$, $R_2=K\Omega$ and $C=0.01\mu F$. Assume necessary data. 15
- 1(b) Solve the following 3rd order linear differential equation with op-amp 15

$$10 \frac{d^3v(t)}{dt^3} + 200 \frac{dv(t)}{dt} + 200v(t) = 205 \text{ volt}$$
- 1(c) Define offset voltage and parasitic capacitance in terms of LM741 op-amp IC. 05
- 2(a) What is Fan-in, Fan-out, propagation delay and figure of merit of an analog IC? 06
- 2(b) Design a circuit to perform the following integro-differential operation. 12

$$y(t) = \frac{1}{2}x(t) + \frac{1}{100} \int x(t)dt + 0.1 \frac{dx(t)}{dt}$$
- 2(c) What are the applications of Schmitt trigger circuit? For the following circuit, find the V_{UTP} and V_{LTP} . 12

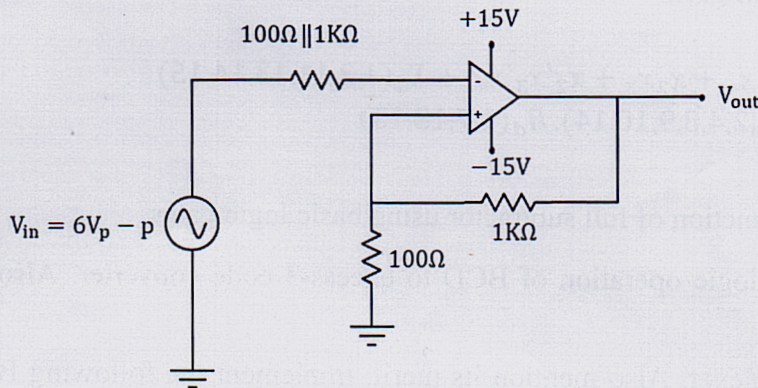


Figure 2 (C)

- 2(d) Give an example of Voltage-controlled oscillator (VCO) IC and draw its pin diagram. 05
- 3(a) Draw a circuit diagram of a differential instrumentation amplifier using transducer bridge and hence find its output voltage V_{out} . 10
- 3(b) Find V_0 for the following circuits. Fig 3(b) 12

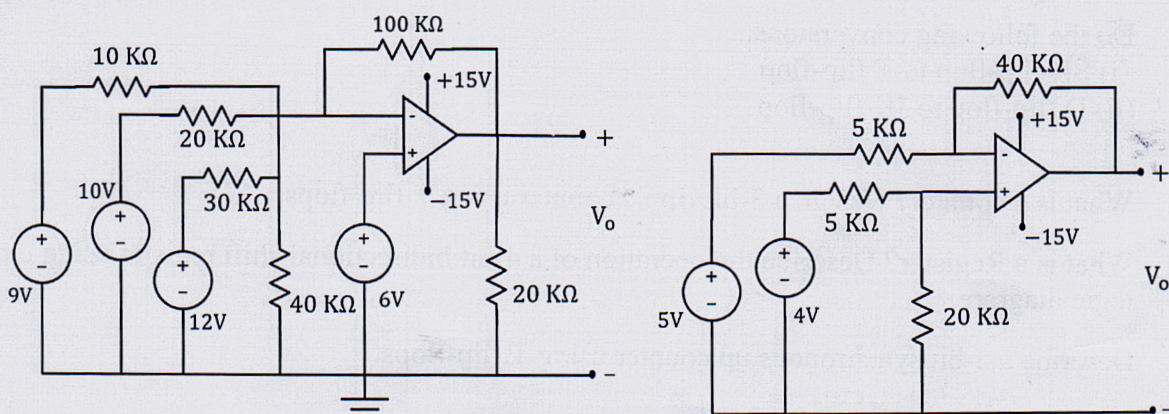


Fig 3 (b)

- 3(c) Draw the circuit diagram of Wien-bridge oscillator and prove that, the voltage gain for this wave form generator is maximum at resonance condition. 13
- 4(a) Write short notes on: 10
 (i) Voltage follower
 (ii) Summing amplifier and
 (iii) All-pass filter
- 4(b) Differentiate between active filter and passive filter. Design a 2nd order wide bandpass active filter with $f_L=200\text{Hz}$, $f_H=2\text{KHz}$, and passive gain of 4. Also calculate the value of Q for the filter. 15
- 4(c) Draw an op-amp circuit to convert a ramp signal into a square-wave signal & derive its output voltage equation. 10

SECTION-B

- 5(a) Why NAND and NOR gates are called universal gates? Explain your answer with example. 10
- 5(b) Consider a logic circuit with three inputs A, B and C. Output F is 1 (high) for the following conditions: 12
 i) A & C are false but B is true
 ii) B & C are false but A is true
 iii) A & C are true but B is false
 iv) A & B are true but C is false
 v) A, B & C are true.
 Minimize the function Y using Boolean algebra.
- 5(c) Minimize the following function in SOP & POS form. Also draw the logic circuit using minimum no of gates. 13
 $f = f_1 \oplus f_2$
 here, $f_1 = x_1'x_4 + x_2x_3 + x_2'x_3'x_4' + \Sigma_d(1,2,11,13,14,15)$
 and $f_2 = \Pi(0,2,4,8,9,10,14) \cdot \Pi_d(1,7,13,15)$
- 6(a) Explain the function of full subtractor using basic logic gates. 10
- 6(b) Describe the logic operation of BCD to excess-3 code converter. Also draw the logic diagram. 10
- 6(c) Define multiplexer. Also mention its merit. Implement the following Boolean function using MUX. 15
 $F(A,B,C,D)=\Sigma m(0,1,2,4,5,6,8,9,12,13,14)$
- 7(a) What is flip-flop? Mention the differences between Flip-Flops and Latches. 'J-K flip-flop is called the refinement of RS flip-flop' justify the statement. 12
- 7(b) What is meant by triggering of a flip-flop? Discuss the process of getting edge triggering in detail. 13
- 7(c) Do the following conversions: 10
 (i) SR flip-flop to T flip-flop
 (ii) D flip-flop to JK flip-flop
- 8(a) What is a counter? Design a 3-bit ripple counter using T flip-flops. 12
- 8(b) What is a Register? Describe the operation of a 4-bit bidirectional shift register using the logic diagram. 13
- 8(c) Describe a 3-bit synchronous up counter using T flip-flops. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 3rd Year 1st Term Examination, 2023

MTE 3107

(Software Development)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if any missing.

SECTION-A

- 1(a) Define constants and variables. What is meant by mnemonic variable names in programming? Explain the benefit of these variable names with example. 10
- 1(b) Explain the difference between mutable and immutable data types in Python with examples. 10
- 1(c) Explain the significance of indentation in Python. What errors might occur if indentation is not used correctly? Why Python is considered an interpreted language even though it uses bytecode? 15
- 2(a) Explain the differences between definite and indefinite loops in Python with example. Illustrate how an iteration can be finished using "continue" statement in Python. 10
- 2(b) Describe the purpose of exception handling in Python. Provide examples of scenarios where exception handling is necessary. 08
- 2(c) Discuss the indexing, slicing and modification operations supported by lists in Python. How are they used and what are their respective syntaxes? 10
- 2(d) Write a Python function that takes a list of words as input and returns a dictionary containing the frequency of each word in the list. 07
- 3(a) Illustrate the difference between a dictionary and a list in Python with example. Write a Python function that takes a dictionary with student names as key and their grades as values. The function should return a new dictionary with student names as key and their grade letter as values based on the following grading scale:
A: 90-100, B: 80-89, C: 70-79, D: 60-69, F: below 60. 15
- 3(b) What is object-oriented programming? Why it is used instead of structural programming. 10
- 3(c) What is Method Resolution Order (MRO) in Python? Explain the differences between class variables and instance variables in Python with proper example. 10
- 4(a) What is class methods in Python, and how are they defined? 05
- 4(b) What is polymorphism in Python? Demonstrate how the method overriding contributes to polymorphism in Python with proper example. 10
- 4(c) Suppose, you are assigned to design a Household Robot. Now, define a Python class 'HouseholdRobot' to represent a robot used for household tasks. The Household Robot should be capable of performing tasks such as cleaning, cooking, and assisting with home security. Design the class with appropriate methods to simulate these tasks. 15
- 4(d) How do you import Matplotlib's pyplot module? Write a Python code to generate a straight line using NumPy array and Matplotlib. 05

SECTION-B

- 5(a) Define software. Give example of four softres where the customer and end user are different. 05
- 5(b) Suppose you are a part of software company currently working on a project to develop a control system software for an aircraft. Which software development life cycle will you suggest and why? Briefly explain the SDLC. 15
- 5(c) Briefly describe the serum agile method. 15
- 6(a) Draw a diagram showing all the requirement engineering activities elaborately. Briefly explain different requirement gathering techniques. 18
- 6(b) Why and how MOSCOW method is used? 12
- 6(c) What are the checks that should be carried out in the validation stage of requirement engineering? 05
- 7(a) What is data flow diagram? Explain its notations. Draw a context level DFD of a bus ticket reservation system with mobile banking facility to purchase. 15
- 7(b) Briefly explain the three golden rules of user interface design. 13
- 7(c) What is cost of quality? Classify it with example. 07
- 8(a) Define defect, failure and problem with example. 09
- 8(b) What are the objectives of testing in SDLC? What are the methods to test a software? Write short note on them. 10
- 8(c) Briefly describe different testing strategies for conventional software. 16

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 3rd Year 1st Term Examination, 2023

MTE 3113

(Numerical Analysis and Statistics)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if any missing.

SECTION-A

1(a) Define interpolation. Deduce Newton formula for forward interpolation with equal intervals. 12

1(b) The population of a country in the decennial census were as follows. Estimate the population for the year 1925. 11

Year	1891	1901	1911	1921	1931
Population (in thousand)	46	66	81	93	101

1(c) Find a real root of the equation $x^2 + \ln x - 2 = 0$ by using false position method. 12

2(a) Deduce Newton-Raphson formula for the solution of transcendental equation. Also show that it converges quadratically. 13

2(b) Solve the following system of linear equations by the Gauss-Jordan elimination method. 16
 $x + 2y - 3z = 0;$
 $2x + 5y + 2z = 0;$
 $3x - y - 4z = 0;$

2(c) Write short notes on: 06
(i) Dirichlet Boundary condition
(ii) Neumann Boundary condition
(iii) Initial value problem

3(a) Evaluate $\int_0^6 \frac{dx}{(1+x)^2}$, by using (i) Trapezoidal rule, (ii) Simpson's 1/3 rule, (iii) Simpson's 3/8 rule. 12

3(b) The following table gives the angular displacements θ (rad) at different intervals of time (sec). Calculate the angular velocity and angular acceleration at instant $t = 0.06$ sec. 13

t	0	0.02	0.04	0.06	0.08	0.10	0.12
θ	0.052	0.105	0.168	0.242	0.327	0.408	0.489

3(c) Derive the expression of the error associated with Simpson's 1/3 rule. 10

4(a) Solve the following equation with 4th order Runge-Kutta method from $x = 0$ to $x = 2$ using $h = 0.5$. 20
 $y'' + 0.5y' + 7y = 0$; Here, $y(0) = 4$ and $y'(0) = 0$.

4(b) Consider a steel plate of size 15cm x 15cm. If two of the sides are held at 100°C and other two sides are held at 0°C, what are the steady state temperature at interior points assuming a grid size of 5cm x 5cm? 15

SECTION-B

5(a) What are the general methods for data visualization? Explain each of them with relevant diagrams. 12

5(b) What are the different measures of central tendency? For two non-zero positive values, show that $A.H = G^2$; where A=Arithmetic mean, H=Harmonic mean and G=Geometric mean. 12

- 5(c) The following data show the age in years of 22 students.
8, 11, 9, 19, 10, 20, 6, 9, 14, 14, 12, 14, 13, 12, 18, 17, 15, 13, 16, 10, 17, 15.
Find the followings:
i) Present the data in a table of frequency distribution taking five as class interval.
ii) Calculate Median and Mode from the frequency table.

- 6(a) What are the measures of dispersion? Which is the best measure in your opinion? Give reasons for your answer. 08

- 6(b) Marks obtained by 40 students in MTE 3105 course are shown below: 15

62	50	46	38	49	48	53	66
54	51	45	56	54	41	51	64
55	63	67	56	52	53	54	57
51	56	61	54	49	68	42	55
58	43	52	59	57	63	57	51

- i) Construct a frequency table taking suitable class interval.
ii) Calculate 5th decile, 50th percentile and standard deviation from the above table.
- 6(c) What is meant by skewness? For a set of 10 observations, the following results were obtained. 12

- i) $\Sigma x = 55$ and $\Sigma x^2 = 385$
ii) The first four central moments of a distribution are 0, 8.8, 0.64, and 248.36. Calculate β_1 and β_2 and state whether the distribution is leptokurtic or platykurtic.

- 7(a) What is the main difference between correlation and regression analysis? Prove that, Pearson's correlation coefficient varies from -1 to +1. 10

- 7(b) By the least square method, calculate and fit the linear equation $y = a + bx$ from the following points. 15

x	-3	-1	0	1	2	4
y	10	11	8	12	9	10

Also determine the corresponding value of y for $x = -2$ and $+6$.

- 7(c) An electromechanical system consists of four components as illustrated in Fig. 6(c). The system works if components A and B work and either of the component C or D work. The reliability of each component is also shown in the Fig. Find the probability that 10

- i) The entire system works and
ii) The component C does not work, given that the entire system works.
Assume that four components work independently.

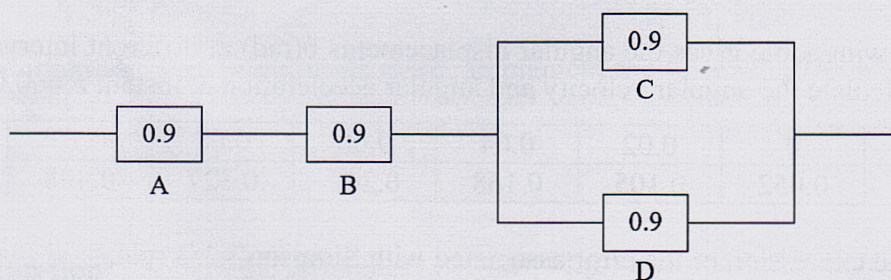


Figure 7(c)

- 8(a) There are four fused balls in a lot of 10 good bulbs. If three bulbs are drawn at random with replacement, find the probability of distribution of the number of fused bulbs drawn. 10

- 8(b) In a village, load-shedding occur randomly at a rate of 10 per year. Find the probability that in any given year there will be 15

- i) Exactly 7 power cuts.
ii) At least 4 power cuts.

Hence, use a suitable approximation to find the probability that in the next 10 years, the number of power cuts will be less than 20.

- 8(c) X is a normal variable with mean 42 and standard deviation 4. Find the probability that a value taken by X is 10

- i) Less than 50
ii) Between 43 and 45
iii) Between 37 and 41