KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 3rd Year 1st Term Examination, 2021
ME 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)   Classify fluids on the basis of various criteria.   08

1(b)   Define following terms: 12
i) Shear stress, ii) Viscosity, iii) Compressibility of fluid, and iv) Surface tension

1(c)   Calculate the kinematic viscosity of an oil having s.g. of 0.84 which is used for lubrication   15
between a square plate of size 0.8 m X 0.8 m and an inclined plane with angle of
inclination 30° as shown in figure below. The weight of square plate is 300 N and it slides
down the inclined plate with a uniform velocity of 0.3 m/s. the thickness of the oil film is
1.5 mm.
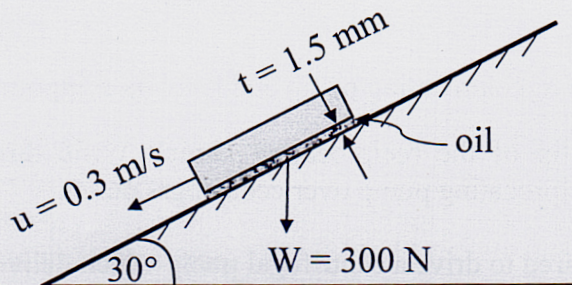
2(a)   What is centre of pressure? Show that the centre of pressure lies below the centre of   17
gravity of the vertical surface.

2(b)   A 4 m long curved gate is located in the side of a reservoir containing water as shown in   18
figure below. Determine the magnitude of vertical and horizontal components of the force
of the water on the gate.
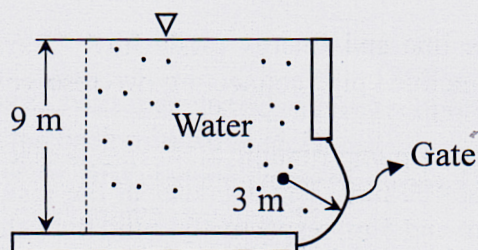
3(a)   What is buoyancy? Discuss necessary condition of stability of a submerged and a floating   13
body with proper figures.

3(b)   Derive Euler's equation of motion for fluid.   15

3(c)   State the Bernoulli's theorem of fluid in motion.   07

4(a)   Describe various types of fluid flow.   08

4(b)   Define following terms: 15
i) Stream line, ii) Streak line, iii) Path line, iv) Vortex, and v) Circulation.

4(c) A certain liquid at 20°C is pumped through a smooth 12 cm diameter pipe which is 10 km long at a flow rate of 75 m³/h. the inlet is fed by a pump at an absolute pressure of 24 atm. The exit is at standard atmospheric pressure and is 150 m higher. Estimate the frictional head loss.

SECTION-B

5(a) Derive an equation of velocity of a laminar flow through a pipe.   17

5(b) Pressure drops over a 30 m long and 1 cm diameter horizontal pipe transporting water at 20°C. The pressure drop between the two ends is measured to be 2 kPa. Assume a laminar flow and viscosity is 10^{-3} N-s-m^{-2}. Determine i) the maximum velocity of water in the pipe and ii) Reynolds number   18

6(a) Define degree of reaction and specific speed of a turbine.   08

6(b) Define following terms: 12
i) Manometric efficiency, ii) Mechanical efficiency, iii) Volumetric efficiency, and iv) Overall efficiency

6(c) What is Net Positive Suction Head? Explain the term "Insufficient NPSH may lead to cavitation and damage to the system".   15

7(a) Draw a schematic of a reciprocating pump and level its components.   10

7(b) What is negative slip of the reciprocating pump? Write down the advantages and disadvantages of reciprocating pump over centrifugal pump.   10

7(c) Find the power required to drive a centrifugal pump which delivers 0.04 m³/s of water to a height of 20 m through a pipe having a diameter of 15 cm and is 100 m long. The overall efficiency of the pump is 70% and coefficient of friction, f = 0.15 in the formula   15
$$h_f = \frac{4fLv^2}{d \times 2g}.$$

8(a) Derive Chezy's formula for loss of head due to friction in pipes.   12

8(b) What is Hydraulic grade line and Energy grade line? Draw hydraulic grade line and energy grade line for an inclined pipe connecting two reservoir considering all losses.   10

8(c) A single acting reciprocating pump running at 40 rpm is discharging 1 m³/min of water. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. the delivery and suction head are 20 m and 5 m, respectively. Find the percentage of slip of the pump and the power required to drive the pump.   13

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 3rd Year 1st Term Examination, 2021
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) A microcomputer is designed to control various appliances in your house. The system has   10
an output port with the address 01H and various units are connected to the bits D_7 to D_0
as shown in fig. 1(a). On a cool morning, you want to turn on the radio, coffee pot, and
Light 2. Write appropriate instructions for the microcomputer.
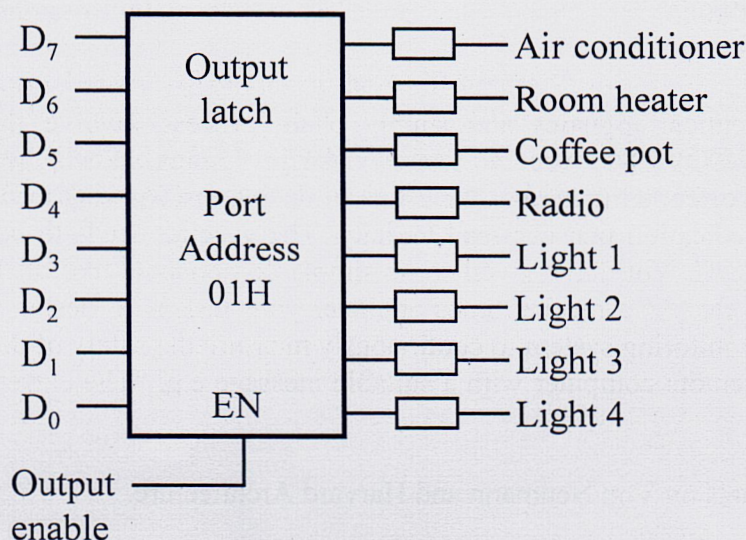
Fig. 1(a)

1(b) Discuss the general-purpose and special-purpose register structure of 8085   11
microprocessor. Why "LDA, 2050H" is a three-byte instructions? Explain.

1(c) Specify the contents of the registers (A, B) and the flag status (S, Z and CY) as the   10
following instructions are executed.

```
MVI A, F8H
SUB A
MOV B, A
DCR B
INR B
SUI 01H
HLT
```

1(d) Compare the actions of following instructions: i) ADD and ADC, ii) INR and INX, and   04
iii) MVI and LXI

2(a) Identify the functional difference between 8085 and 8086 microprocessors. Explain the   10
technique of generating 20-bit physical address using segment registers in 8086
microprocessor environment.

2(b) Describe the closely coupled configuration of multiprocessor mode in 8086   10
microprocessor. Write down the significance of HOLD and HLDA signals by means of
proper waveforms.

2(c) Draw a bit pattern of flag register of Intel 8086 and write down the functions of each flag bit in brief.

2(d) Write down a simple assembly language program in 8086 to multiply two 16-bit numbers stored in memory and to store the result of 32-bit in memory. 0

3(a) What is interrupts? Write down the interrupt types of 8085 with examples. 06

3(b) Write down the key features of 8255 programmable peripheral interface and 8257 DMA controller. 10

3(c) Write an assembly language program in 8086 that reads the temperature of cleaning bath solution and lights one of the two lamps according to temperature read. If the temperature is <30°C, a yellow lamp will be turned on. If the temperature is ≥ 30°C, a green lamp will be turned on. 11

3(d) Describe the actions of 8086 microprocessor after it is interrupted. Explain hardware interrupting of 8086. 08

4(a) The pharmaceutical logistics and supply chain process involve the movement of Astrazeneca's COVID-19 vaccine from Dhaka to Khulna. When these productes are exposed to incorrect temperature, the effect of decomposition can occur. This may lead to a ruined medication that can lead toxicity. The vaccine needs to be kept at a range between 2 to 8°C. You have given some simple components like AVR32, LM35, and LCD display, etc. As a mechatronics engineer your task is to design a high precision temperature monitoring system to continuously measure the safety of the drugs and send the data to a remote computer with a suitable message e.g. "The current temperature is 4°C". 20

4(b) Write short notes on Von Neumann and Harvard Architecture. 10

4(c) Show how to make the external INT0 negative edge triggered. 05

SECTION-B

5(a) What is data memory and program memory of the AVR microcontroller? 08

5(b) Mention some factors that can affect time delay in AVR microcontroller. 05

5(c) Assume that the INT0 and INT1 are connected to two switches, namely S1 and S2. Write an AVR program in which whenever S1 goes low, the content of PORTC increases by one; and when S2 goes low, the content of PORTC decreases by one. When the value of PORTC is greater than 100, PD2 is high; otherwise, it is low. 12

5(d) Draw the power and reset circuit for AVR microcontroller. 10

6 Design an AVR microcontroller based student attendance system. A student counter is required that can count the students. Number of students are known (e.g. 28 students). Students are entering the lecture room one by one. There are two conditions for the lecture room door to be locked. After all the student entered the room or after 15 mins of the lecture start time. Lecture time is conveyed by the instructor by pressing a push button at the lecture room entrance. 35
    i) Draw the block diagram of the system that consists of all the required external hardware modules (e.g. LCD display, motor, switches, etc.) and their interface with AVR microcontroller.
    ii) Draw the flow chart of your design.
    iii) Write down an AVR based C program for the above system.

a) The main concept of this system is to switch ON a water pump automatically when the water goes below a certain level. Here the designer sets it 25%. If the water goes below it, the pump motor will start automatically. And the pump motor becomes OFF when the water level goes above 90%.

The signal pin of liquid level sensor gets connected to an analogue pin on the AVR ATmega32 microcontroller. This allows the AVR chip to be able to read analogue voltage value. The AVR program should program as the following:

    i) If the measured voltage is above 25%, then the motor holds its normal speed.

    ii) If the measured voltage is above 50%, then the motor should accelerate.

    iii) If the measured voltage is above 90%, then the motor should stops instantly.

18

7(b) What is watchdog timer? Assume that Timer1 and Timer0 overflow interrupts are both enabled. Explain what will happen if both TOV1 and TOV0 are activated at the same time.

07

7(c) Write a program to generate a delay of 1920 µs. Use prescale of 64 and XTAL = 8MHz.

10

8(a) What are the sources of interrupt in AVR?

10

8(b) Describe the Normal and CTC modes of the AVR timers.

10

8(c) A door sensor is connected to bit 1 of PORTB and a LED is connected to bit 7 of PORTC. Write an AVR C program to monitor the door sensor and when it opens, turn on the LED.

13

8(d) What is duty cycle?

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 3rd Year 1st Term Examination, 2021
MTE 3105
(Linear Integrated Circuits and Digital Systems)
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) Define the following electrical parameters: i) input offset voltage, ii) input resistance, iii) CMRR, iv) output voltage, and v) slew rate   10

1(b) What is meant by current mirroring and virtual ground? The input to the differentiator circuit of Fig. 1(b) is a sinusoidal voltage of peak value of 10 mV and frequency of 5 kHz. Find out the output if R = 1 MΩ and C = 0.1 µf   10
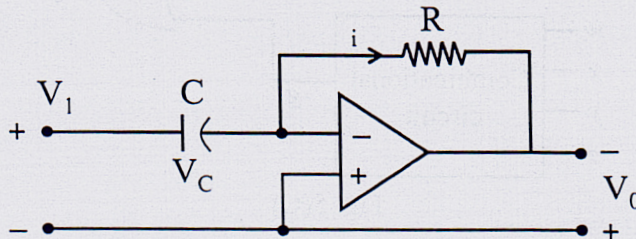
Fig. 1(b)

1(c) Solve the following 3rd order linear differential equation with op-amp.   15

$$10\frac{d^3v(t)}{dt^3} + 200\frac{dv(t)}{dt} + 2000\,v(t) = 205\;volt$$

2(a) Draw the circuit diagram of a differential instrumentation amplifier using transducer bridge and hence find its output voltage V_{out}.   10

2(b) Write down the advantages of active filter over passive filter. Design a second order wide bandpass active filter with f_L = 200 Hz, f_H = 2kHz, and passband gain of 4. Also calculate the value of Q for the filter.   12

2(c) Prove that the magnitude of output voltage, V_{out} will be equal to one-third of the input voltage, V_{in} for a Wein-bridge oscillator at the oscillation frequency, f_r.   13

3(a) What do you mean by comparator? List the important characteristics of a comparator. What are the differences between a basic comparator and Schmitt trigger?   10

3(b) Draw the circuit diagram of zero level detector and illustrate its operation with neat sketch of relevant waveforms.   10

3(c) Draw the block diagram of phase-locked loop (PLL). Why low pass filter is used in PLL? Mention five key applications of PLL.   10

3(d) "An all pass filter is called as phase corrector". Justify this statement.   05

4(a) Explain the working principle of voltage to frequency conversion A/D converter using op-amp IC 566.   10

4(b) A 4-bit R-2R D/A converter is constructed to control the speed of a small DC motor using the output of a digital logic circuit. If the logic circuit uses 10 V CMOS devices, calculate the analogue output voltage from the D/A converter when the input code is hexadecimal number "B". Also determine the resolution of the D/A converter.   12

4(c) Design an astable multivibrator using timer IC 555 having pulse repetition frequency of 2 kHz and duty cycle of 66%. Assume any standard capacitor value (should be less than 1μF).   13

SECTION-B

5(a) Define fan out, propagation delay, and figure of merit in terms of standard TTL gates.   05

5(b) "It is possible to convert a full adder into a full subtractor by merely complementing an input prior to its application to the gates that form the carry output." Justify the statement.   10

5(c) For the following circuit shown in fig. 5(c)   10
    i) What must be 'g' in order that $f = \sum(0, 1, 2, 3, 4, 7, 8, 11)$
    ii) Draw a K'map for 'g'
    iii) Draw the logic circuit of 'g' using minimum gates.
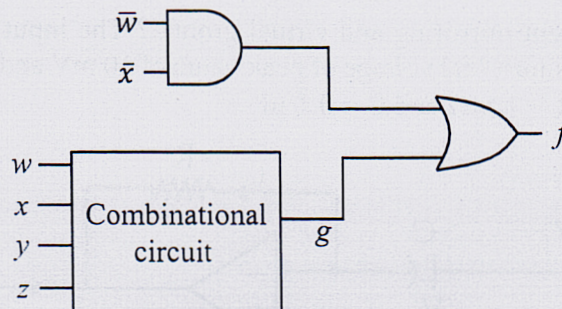
Fig. 5(C)

5(d) What do you mean by error detection code? Design a 3-bit odd parity generator and a 3-bit odd parity checker circuits.   10

6(a) What is meant by combinational and sequential logic circuit? Implement F = (AB + E) (C + D) with NAND and NOR gates.   10

6(b) Express the complement of following functions in SOP and POS form.   10
    i) $F(A, B, C, D) = \sum(0, 2, 6, 11, 13, 14)$
    ii) $F(x, y, z) = \prod(0, 3, 6, 7)$

6(c) What is PLD? Show a comparison table between PROM, PLA, and PAL.   07

6(d) Design a combinational circuit using ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number.   08

7(a) What is flip-flop? Show the differences between latch and flip-flop in tabular form with proper circuit diagrams.   06

7(b) Do the following conversions: i) D flip-flop to JK flip-flop and SR flip-flop to T flip-flop.   08

7(c) What do you mean by triggering of a flip-flop? If the S and R waveforms in fig. 7(c) are applied to inputs of a NAND SR latch, then determine the waveforms that will be observed on the Q and $\bar{Q}$ outputs. Assume that Q is initially low.   07
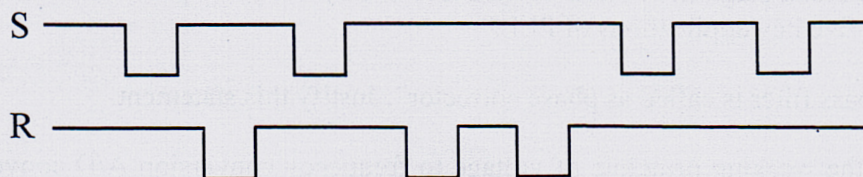
Fig. 7(c)

7(d) A sequential circuit has three D flip-flops (A, B, C) and one input, x. it is described by the following flip-flop input functions.   14

$$DA = (BC' + B'C)x + (BC + B'C')x'$$
$$DB = A$$
$$DC = B$$

    i) Derive the state table for the circuit.
    ii) Draw two state diagrams: one for x = 0 and the other for x = 1

8(a)   What is a register? Describe the operation of a 4-bit bi-directional shift register with   14
       parallel load using the logic diagram.

8(b)   What is a counter? Design a MOD 4 counter using MOD 8 counter and show a timing   10
       diagram up to the 8th clock pulse.

8(c)   What is the main advantage of Johnson counter over ring counter? With the help of D flip-   11
       flop, design a 4-bit switch-tail ring counter showing the outputs of the eight timing signal.
       Also obtain the state diagram.

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SECTION-A

1(a) What are the basic data types in Python?   08

1(b) Discuss the various operation that can be performed on a tuple and list with example.   12

1(c) Write a program (Python) to create a histogram from a given list of integers.   15

2(a) Describe in detail about lambda function.   08

2(b) Define function overloading and operator overloading.   07

2(c) What is abstract data type?   05

2(d) Explain in detail about   15
    i) Creating a dictionary
    ii) Accessing values in dictionary
    iii) Updating a dictionary
    iv) Deleting elements from dictionary

3(a) What exactly is object-oriented programming?   08

3(b) What is inheritance and polymorphism? Explain with proper example.   12

3(c) What are the modeling methodologies of OOP? Mention different UML diagram. Briefly   15
describe class diagram.

4(a) Create a 'Queue' that acts as an ADT such that Q (queue) supports the following methods: 15
    i) Adds an element to the back of the queue, Q
    ii) Removes and returns the first element from the queue, Q. Error occurs if empty.
    iii) Returns the number of elements in queue, Q
    iv) Returns a reference to the first element of queue, Q without removing it. Error
    occurs if empty.

4(b) Write a Python program to simulate a bank account with support for depositMoney,   10
withdrawMoney, and showBalance operation.

4(c) Open a file 'romeo.txt' and read it line by line. For each line, split the line into a list of   10
words using split() method. The program should build a list of words. For each word on
each line check to see if the word is already in the list and if not append it to the list. When
the program completes, sort and print the resulting words in alphabetical order.

SECTION-B

5(a) What are the characteristics of a software? Briefly describe the generic phases of software development.

5(b) Briefly describe incremental model to develop software. Mention its advantages. How is it different from prototyping? 15

5(c) What is agile manifesto? Mention some good practices of extreme programing. 05

6(a) Define software requirement. What are the properties of good requirement? 06

6(b) What is requirement elicitation? Briefly describe the processes of software elicitation. 15

6(c) Define functional, nonfunctional, and implemental requirement with example. 09

6(d) What is PDL? Why do we use it? 05

7(a) Briefly describe different levels of software design. How are these connected to analysis modeling? 15

7(b) Define software quality control. What are the seven principles of quality management mentioned in ISO 9001:2015? 10

7(c) Define cohesion, coupling, modularity, cardinality, and modality. 10

8(a) What is analysis modeling? Briefly describe the elements of analysis modeling. 15

8(b) Define white box and black box testing. Briefly describe why they are complementary to each other. 10

8(c) What is cyclomatic complexity? Find the cyclomatic complexity of the flow graph shown in figure below using i) region and ii) edge and node. 10
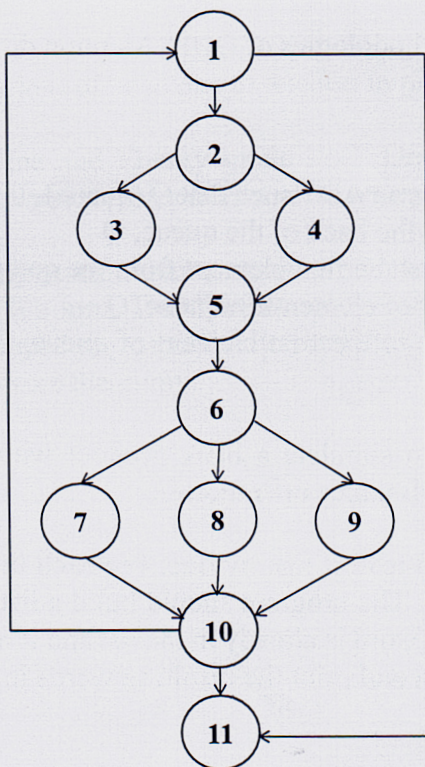
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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 3rd Year 1st Term Examination, 2021
MTE 3113
(Numerical Analysis and Statistics)

Time: 3 Hours   Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.
　　　　 ii) Figures in the right margin indicate full marks.
　　　　 iii) Assume reasonable data if any missing.

SECTION-A

1(a)　State the difference between an analytical and a numerical solution.　　06

1(b)　Use Secant method to find the root of the following function:　　12

$$f(x) = \frac{667.38}{x}(1 - e^{-0.146843x}) - 40$$

Stopping criterion is $\varepsilon_s = 0.5\%$.

1(c)　Define interpolation. The following table shows the population of Khulna city in the last　　17
six censuses. Estimate the increase in the population during the period from 1986 to 1988.

Year	1951	1961	1971	1981	1991	2001
Population (in Thousands)	65	133	340	661	1023	1254

2(a)　Deduce Newton-Raphson formula for the solution of transcendental equation. Also show　　20
that it converges quadratically.

2(b)　Find a real root of the solution of the equation $e^{-x} = 10x$ using False position method,　　15
correct up to eight decimal places.

3(a)　Show that the following equations are consistent and solve them by Guess elimination　　18
method.

$$x - y - z + u = 0$$
$$2x + 2z = 8$$
$$-y - 2z = -8$$
$$3x - 3y - 2z + 4u = 7$$

3(b)　Using 4th order Runge-Kutta method, solve $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$; for $x = 0.2$ and $x = 0.4$ with $h =$　　17
0.2. Given $y(0) = 1$

4(a)　Write short notes on (i) significant digit, (ii) truncation error, and (iii) Dirichlet and　　06
Neumann boundary conditions.

4(b)　Find $\frac{d^2y}{dx^2}$ at $x = 51$ from the following data:　　12

x	50	60	70	80	90
y	19.9	36.6	58.8	77.2	94.6

4(c)　Solve $\nabla^2 f = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 \le y \le 3$ with $f = 20$ on　　17
boundary assuming $h = 1$.

SECTION-B

5(a) Discuss the importance of studying statistics from the perspective of mechatronics engineering.

5(b) Define dispersion. What are the ways of measuring dispersion? Explain with example.   08

5(c) Define probability density function and cumulative distribution function with example. Deduce Bayes' formula.   10

5(d) Ten persons of varying ages were weighted and the following weights in kg were recorded: 65, 75, 78, 68, 67, 82, 69, 77, 71, and 70. Compute interquartile range, 3rd decile, and 25th percentile of this data set.   12

6(a) A PLC manufacturing company has three production units namely X, Y, and Z which produces 40%, 35%, and 25% of the entire production, respectively. Unit X is known to produce 15% defectives, Unit Y produces 8% defective and Unit Z produces 0% defectives. If total 5500 PLCs were manufactured in December 2021, how many products were defectives? If an item is found to be defective, what is the probability that is was produced in Unit Y?   15

6(b) An electromechanical system consists of four components as illustrated in fig. 6(b). 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 figure. Find the probability that (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.   10
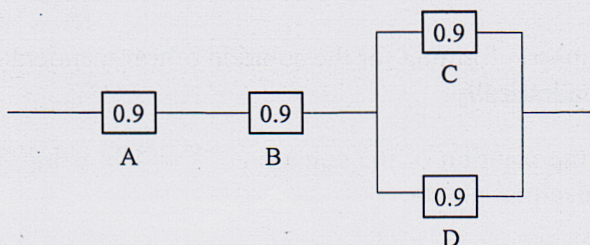

Fig. 6(b)

6(c) Write down the properties of normal probability distribution. For which condition normal distribution can be used as an approximation to the binomial distribution?   10

7(a) Define skewness and kurtosis. Fine coefficient of skewness and kurtosis using moments from the frequency distribution of Table I showing height of 100 students from MTE department. Also comment on the shape of data distribution.   16

Table I

Height (cm)	No. of students
120-129	5
130-139	5
140-149	12
150-159	25
160-169	30
170-179	15
180-189	8

Total students = 100

7(b) What are the demerits of covariance in order to determine correlation between two variables? Prove that Pearson's correlation coefficient varies from -1 to +1.   11

7(c) The correlation between the number of times absent and a final grade is -0.975. There are seven pairs of data. Test the significance of this correlation.   08

8(a) What are the similarities and differences between the t-distribution and standard normal distribution?   05

8(b) Determine the constants a_0 and a_1 by the least square method such that $y = ae^x$. Also fit the following data: 10

x	2	4	6	8	10
y	4.077	11.084	30.128	81.897	222.62

8(c) Table II shows the daily wage distribution in a certain factory. Draw a 2D pie chart of the frequency distribution and then calculate i) mean, ii) mode, iii) median, iv) standard deviation, and v) coefficient of mean distribution.   20

Table II

Daily wage (tk)	No. of employees
70-90	17
90-110	23
110-130	42
130-150	102
150-170	78
170-190	52
190-210	26

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