BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **BME 201** (Biomechanics)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Symbols carry their usual meaning. Reasonably assume any missing data.

1. (a) A femur bone was mounted in the grips of a torsion testing machine. The femur was subjected to pure torsional loading until fracture. The fracture shape was found to be spiral and the fracture surface was at 45° to the longitudinal axis of the bone. The same test was carried with a second sample but this time in addition to torsion an axial tensile load was also applied. But the exact amount of the tensile load could not be determined. In this second case, the fracture shape was spiral again and the fracture surface was at 80° to the longitudinal axis of the bone. The cross sectional geometry of the bony tissue for both samples was observed to be a circular ring with inner radius of 7 mm and outer radius of 13 mm. **(20)**

(i) Determine the cause of the failure from test-1.

(ii) If the cause of the failure is same for test-2, estimate the value of the applied tensile load. Mention the necessary assumptions for solving the problem.

Test	Longitudinal load Applied	Torsional load applied (Nm)	Angle of fracture with respect to longitudinal axis
1	No	180	45°
2	Yes	125	80°

(b) Fig. for Q. No. 1(b) illustrates a fixation device consisting of a plate and two screws, which can be used to stabilize fractured bones. During a single leg stance, a person can apply his/her entire weight to the ground via a single foot. In such situations, the total weight of the person is applied back on the person through the same foot. In the case of a patient with a fractured leg bone (in this case, the femur), this force is transferred from below to above (distal to proximal) the fracture through the screws of the fixation device. If the diameter of the screws is 5 mm and the weight of the patient is 70 kg, determine the shear stress exerted on the screws of a two-screw fixation device during a single leg stance on the leg with a fractured bone. **(5)**

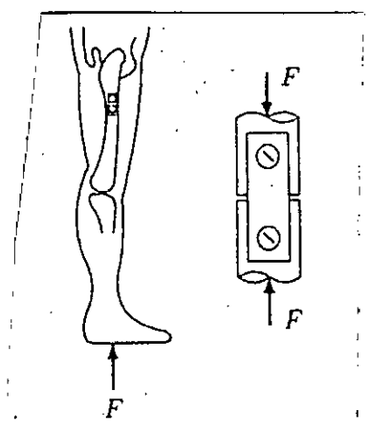

Fig. for Q no. 1 (b)

Contd P/2

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Contd. Q. No. 1

(c) Compare the loading-unloading behaviors of linear elastic, viscoelastic solid and viscoelastic fluid materials. What happens to the temperature of a viscoelastic material during the unloading phase? Why? **(10)**

2. (a) Does the tension which a muscle fiber can generate depend on its length? If yes, describe how. **(10)**

(b) What total axial force can be generated by a pinnate muscle having the form and dimensions shown in Fig. for Q. No. 2(b)? The force developed by muscle per unit cross-sectional area may be taken as 20 N/cm^2. **(10)**

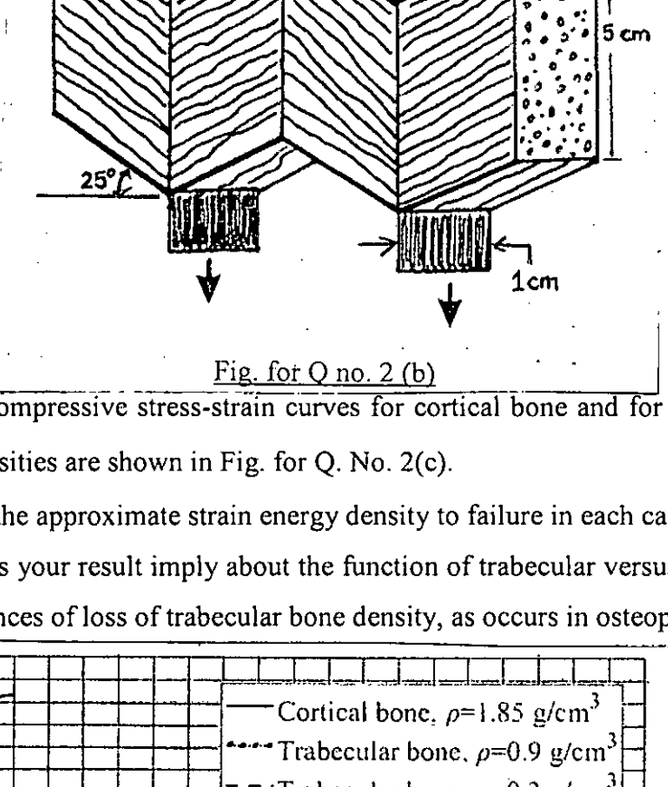

Fig. for Q no. 2 (b)

(c) The typical compressive stress-strain curves for cortical bone and for trabecular bone of two different densities are shown in Fig. for Q. No. 2(c). **(15)**

(i) Calculate the approximate strain energy density to failure in each case.

(ii) What does your result imply about the function of trabecular versus cortical bone and the consequences of loss of trabecular bone density, as occurs in osteoporosis.

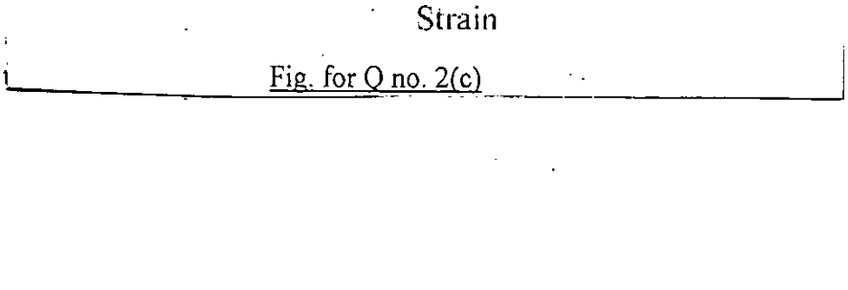

Fig. for Q no. 2(c)

Contd P/3

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3. (a) Consider a cell that has a magnetic bead attached to it. Treat the cell as a three parameter Kelvin body as shown in Fig. for Q. No. 3(a). Suppose that the magnetic field has been turned on for a very long time and is producing a constant force on the bead F_0. At time t=0, the force is suddenly switched off. Derive an expression for the resulting displacement of the bead as a function of time, x(t). **(18)**

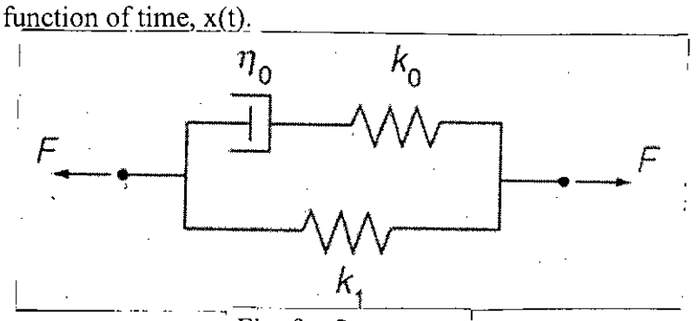

Fig. for Q no. 3(a)

(b) Specific adhesion between a cell and another cell of a solid surface occurs because bonds are formed between membrane receptors and their ligands. Design an experiment to measure the force required to detach from such a bond. **(12)**

(c) How does trabecular bone behave under compressive load? **(5)**

4. (a) Derive an expression for the height attained by the center of gravity during a standing jump, relating it to crouch depth and average push-off force. Mention necessary assumptions. **(11)**

(b) A subject of mass 65 kg has her gait analyzed. Suppose that the x component of the force measured by a force plate takes the shape shown in Fig. for Q. No. 4(b) **(12)**

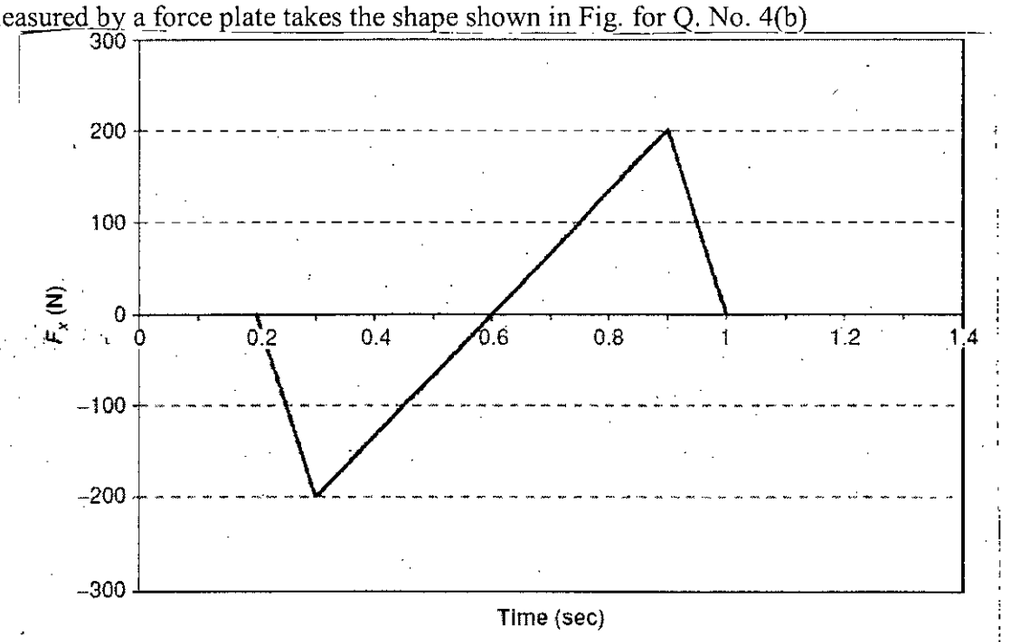

Fig. for Q no. 4(b)

(i) If the forward velocity of the walker is 2 m/s at heel strike, what is it 0.4 s after heel strike?

(ii) Estimate the corresponding change in height for the subject's center of gravity (i. e., from heel strike to 0.4 s later) State the assumptions you have made to solve the problem.

(c) Describe the major phases and movement of the bipedal gait cycle. **(12)**

Contd P/4

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SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) The tibia is the major-bearing bone in the lower extremity. 80% of the body mass is proximal to the knee joint. How much compressive force acts on each tibia when: **(15)**

(i) a 70 kg person stands in anatomical position?

(ii) the person holds a 30 N sack of groceries on his head?

(iii) the person holds a 30 N sack of groceries on his hand?

(b) Consider that a package of sugar of 2 kg is in the hand of a horizontally outstretched arm. Find the associated torque about the axis of rotation passing through the elbow. You need to calculate the required length and mass of the respective body segments using the following figure. Note that the height and weight of the person are 1.7 m and 60 kg, respectively. **(20)**

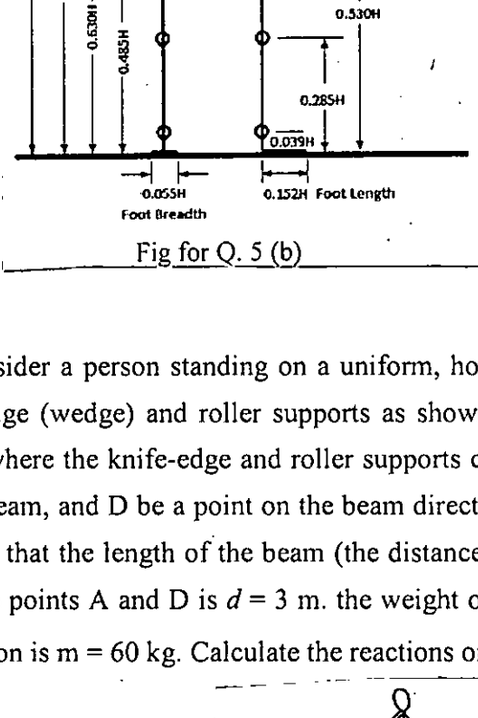

Fig for Q. 5 (b)

Table for Q 5 (b)

Segment	% Mass
Total body	100
Body less all limbs	58.04
Upper arm	3.57
Forearm	1.80
Hand	0.6
Thigh	9.46
Shank	4.20
Foot	1.35

6. (a) Consider a person standing on a uniform, horizontal beam that is resting on frictionless knife edge (wedge) and roller supports as shown in Fig. for Q. 6(a). Let A and B be two points where the knife-edge and roller supports contact the beam, C be the center of gravity of the beam, and D be a point on the beam directly under the center of gravity of the person. Assume that the length of the beam (the distance between A and B) is l = 5 m, the distance between points A and D is d = 3 m. the weight of the beam is W_1 = 900 N, and the mass of the person is m = 60 kg. Calculate the reactions on the beam at points A and B. **(12)**

Fig for Q. 6 (a)

Contd P/5

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Contd. ... Q. No. 6

(b) Why is it important to have access ramps in the hospitals? Fig. for Q. 6(b) represents situation in which simple machines based on inclined planes are employed. Determine action force and the mechanical advantage of the system. **(15)**

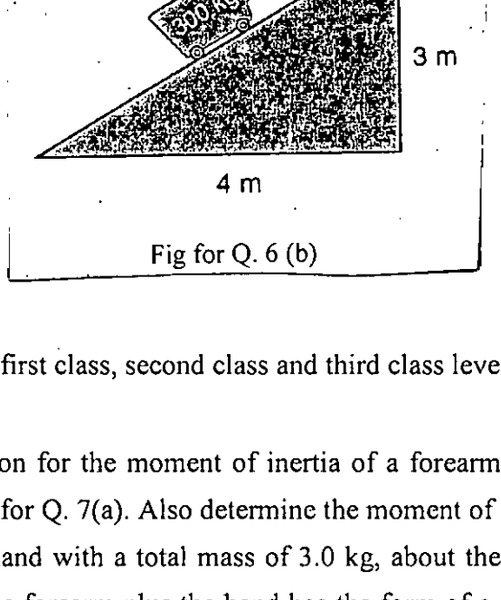

Fig for Q. 6 (b)

(c) Give examples of first class, second class and third class lever of human body. **(8)**

7. (a) Derive the equation for the moment of inertia of a forearm plus hand about rotation of axis as shown in Fig. for Q. 7(a). Also determine the moment of inertia and radius of gyration of a forearm plus a hand with a total mass of 3.0 kg, about the axis of rotation (Fig. for Q. 7(a)). Suppose that the forearm plus the hand has the form of a cylinder with length equal to 0.38 m and radius of 0.03 m. **(26)**

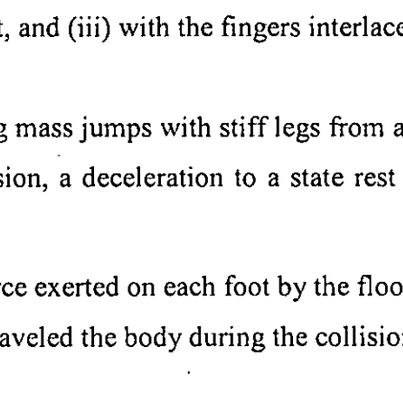

Fig. for Q. 7(a)

(b) Discuss the reason for progressive difficulty in abdominal exercises, lying flat on the back: (i) with outstretched arms and the hands in the direction of the feet, (ii) with the arms crossed over the chest, and (iii) with the fingers interlaced under the head. **(9)**

8. (a) A woman of 60 kg mass jumps with stiff legs from a table of 1 m height onto a hard floor tile. During the collision, a deceleration to a state rest occurs in a time interval of 0.005 s. Calculate: **(10)**

   (i) the average force exerted on each foot by the floor and

   (ii) the distance traveled the body during the collision.

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Contd. ... Q. No. 8

(b) During a practice, a shot-putter puts the shot at a distance l = 6 m. At the instant the athlete releases the shot, the elevation of the shot is h_0 = 1.8 m as measured from the ground level, and the angle of release is $\theta = 30°$ (Fig. for Q. 8(b)). Determine the speed at which the athlete released the shot, the landing speed of the shot, and the total time the shot was in the air. **(11)**

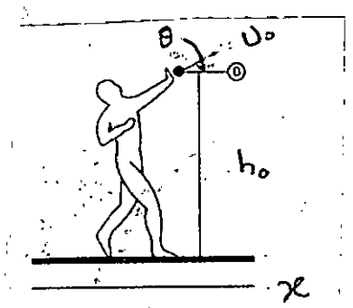

Fig. for Q. 8(b)

(c) The ski jumper in Fig. for Q. 8(c) is moving down a track to acquire sufficient speed to accomplish the jumping task. The length of the track is l, the track makes an angle θ with the horizontal, and the coefficient of friction between the track and the skis is μ. **(14)**

If the jumper starts at the top of the track with zero initial speed, determine expression for:

(i) The takeoff speed v_2 of the ski jumper at the bottom of the track using the work-energy theorem

(ii) The acceleration a_x of the ski jumper using equation of motion.

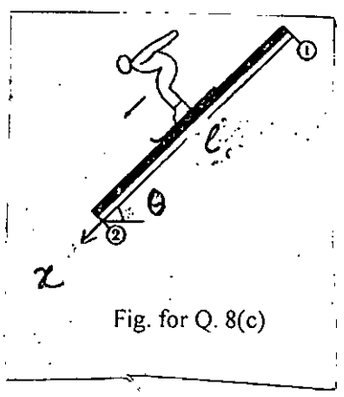

Fig. for Q. 8(c)

Assume that effects of air resistance are negligible.

L-2/T-1/BME Date: 03/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **HUM 241** (Economics)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) What are the assumptions of a perfectly competitive market? Explain. **(10)**

   (b) Explain the short-run equilibrium of a firm under perfect competition. **(15)**

   (c) From the following revenue and cost functions, calculate the profit maximizing level of output and maximum profit. **(10)**

$$R = 1200\,Q - 2Q^2$$

$$C = Q^3 - 61.25Q^2 + 1538.58Q + 3000$$

2. (a) When does a firm emerge as a monopolist? **(10)**

   (b) Explain the short run equilibrium of a firm under monopoly. **(10)**

   (c) What is the relation among marginal revenue (MR), price (P) and price elasticity of demand(e). **(10)**

   (d) What are the conditions of profit maximization? **(5)**

3. (a) What do you understand by internal economies of scale? Explain different types of internal economies of scale. **(20)**

   (b) What are the advantages and disadvantages of division of labour? **(15)**

4. (a) How would you derive the long run average cost curve of a firm from its short run average cost curves? Explain graphically. **(10)**

   (b) Define fixed cost and variable cost. **(5)**

   (c) A manufacturer has a fixed cost of $50,000 and a variable cost of $2.60 per unit made and sold. Selling price is $3 per unit. **(10)**

   (i) Find the revenue, cost and profit functions using q for the number of units.

   (ii) Compute profit if 15000 units are made and sold.

   (iii) Compute profit if 1000 units are made and sold.

   (iv) Find the break-even quantity.

   (v) Construct the break-even chart. Label the cost and revenue lines, the fixed cost line, and the break-even point.

Contd P/2

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Contd... Q. No. 4

(d) Complete the following table and sketch the graph explaining the relations among the various short run cost corves. **(10)**

Quantity of output	Total fixed cost	Total variable cost	Total cost	Average fixed cost	Average variable cost	Average total cost	Marginal cost
1	80	40					
2	80	50					
3	80	55					
4	80	65					
5	80	85					
6	80	120					

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Clarify the concept of utility in Economics and explain the law of diminishing marginal utility with numerical as well as graphical presentations. **(10)**

(b) Explain the condition of the consumer equilibrium for a single commodity under the cardinal approach to utility analysis and mathematically derive the condition. **(10)**

(c) What do you know about the fundamental economic problems and how are these problems addressed in different economic systems? Explain. **(15)**

6. (a) What do you understand by marginal rate of substitution (MRS). Establish its relationship with marginal utility. **(10)**

(b) 'People buy more when commodity price falls and vice versa.' Explain this statement with the help of income effect and substitution effect of a price change. **(10)**

(c) How would you split the income effect and substitution effect of a price rise? (Use appropriate graphs.) **(15)**

7. (a) Clarify the concepts of GNP, GDP and NNP. **(10)**

(b) What are the methods of measuring national income? Explain any two of them. **(10)**

(c) Discuss the problems of measuring national income in a developing country with reference to the context of Bangladesh. **(15)**

8. Write short notes on any THREE of the following: **(35)**

(a) Change in supply and change in quantity supplied

(b) Determinants of demand for electricity in Bangladesh

(c) Types of elasticity of demand and their applications

(d) Procedure of cost-benefit analysis (CBA).

L-2/T-1/BME Date : 09/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **MATH 213** (Differential Equations)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Find the differential equation by eliminating arbitrary constants a and b from the equation $y = ae^{3x} + be^{-2x}$ **(10)**

   (b) Solve the following differential equations: **(13)**

   i. $(2x-2y+5)dy = (x-y+3)dx$ **(12)**

   ii. $\left(2\sqrt{xy}-y\right)dx = xdy$

2. (a) Find the integrating factor and then solve **(12)**

   $$x\left(1-x^2\right)\frac{dy}{dx}-\left(2x^2-1\right)y=x^3$$

   (b) Check whether the differential equation $(xy^2 + y^2 + y)dx + (2xy + 1)dy = 0$ is exact or not. If not, then reduce it into exact form and hence solve. **(12)**

   (c) The number of bacteria in a yeast culture grows at a rate which is proportional to the number present. If the population of a colony of yeast bacteria triples in 1 hour, find the number of bacteria which will be present at the end of 6 hours. **(11)**

3. (a) Solve the following higher order differential equations: where $D=\frac{d}{dx}$: **(24)**

   i. $\left(D^2-4D-5\right)y=xe^{-x}$

   ii. $\left(D^2+2D+1\right)y=x\sin x$

   (b) Convert the following differential equation to Cauchy-Euler's equation by using appropriate substitution and hence solve: **(11)**

   $$(x+1)^2\frac{d^2y}{dx^2}+(x+1)\frac{dy}{dx}=4x^2+14x+12$$

4. (a) Solve the following non-linear differential equation: **(10)**

   $$p^2+2py\cot x=y^2, \text{where } P\equiv\frac{dy}{dx}$$

   (b) Use variation of parameter method to solve: **(12)**

   $$4\frac{d^2y}{dx^2}-4\frac{dy}{dx}+y=e^{x/2}\sqrt{1-x^2}$$

   (c) Solve the following differential equation by the method based on the factorization of the operator: **(13)**

   $$(x+1)\frac{d^2y}{dx^2}+(x-1)\frac{dy}{dx}-2y=0.$$

MATH 213/BME

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Symbols used have their usual meaning.

5. (a) Identify the nature of singular points of the following differential equations: **(10)**

(i) $\left(1-x^2\right)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+n(n+1)y=0$

(ii) $(x-1)^3\frac{d^2y}{dx^2}+3(x-1)^2\frac{dy}{dx}+y=0$

(b) Use Frobenius method to find the series solution of the differential equation

$\left(2x+x^3\right)\frac{d^2y}{dx^2}-\frac{dy}{dx}-6xy=0.$ **(25)**

6. (a) Find the integral surface of the first order linear partial differential equation:

$2y(z-3)p+(2x-z)q=y(2x-3)$ **(15)**

which contains $z = 0$, $x^2 + y^2 = 2x$.

(b) Find the complete and singular integral (if it exists) of the partial differential equation **(12)**

$\left(p^2+q^2\right)x=pz$.

(c) Find the singular solution of the differential equation $z = xp + yq + \log(pq)$ **(8)**

7. Solve the following partial differential equations:

(i) $\left(D_x^2-4D_xD_y+4D_y^2\right)z=24xy^2+e^{3x+y}$ **(17)**

(ii) $\left(x^2D_x^2-2xyD_xD_y-3y^2D_y^2+xD_x-3yD_y\right)z=x^2y\sin\left(\ln x^2\right)$ **(18)**

8. (a) Solve: $\left(3D_x^2-2D_y^2+D_x-1\right)z=4e^{x+y}\sin(x+y)$ **(12)**

(b) Solve the initial-boundary value problem using the method of separation of variables: **(23)**

$\frac{\partial^2u}{\partial t^2}=9\frac{\partial^2u}{\partial x^2}$ *for* $0<x<2, t>0,$

Subject to the boundary conditions $u(0,t) = 0$, $u(2,t) = 0$ for $t \geq 0$

and initial conditions $u(x,0) = x(x - 2)$, $u_t(x,0) = g(x)$ for $0 \leq x \leq 2$,

where $g(x)=\begin{cases}0, & 0\leq x<\frac{1}{2};1<x\leq 2\\ 3, & \frac{1}{2}\leq x\leq 1\end{cases}$

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **EEE 273** (Basic Electronic Devices and Circuits)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) The PMOS and NMOS shown in the circuit below are perfectly matched with $k_n(W/L) = k_p(W/L) = 1$ mA/V^2 and threshold voltage magnitudes of 1V. Channel length modulation is negligible in both the devices. Calculate the output voltage (v_O) and drain currents for both these transistors for three different input voltages (v_I) as mentioned below: **(20)**

   (i) $v_I = 0$ V

   (ii) $v_I = 3$ V

   (iii) $v_I = -2$ V

   Based on your obtained results, comment on a possible application of this circuit.

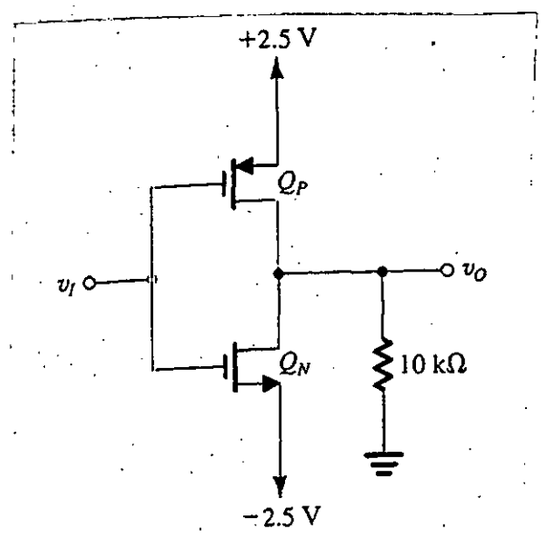

Fig. for Question no 1(a)

(b) Draw transfer characteristics of the circuit shown in the figure below and clearly identify and label on the plot different modes of operation of the MOSFET. Also explain which modes of operations are suitable for the MOSFET to operate as a switch or as an amplifier. **(15)**

Contd P/2

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Contd... Q. No. 1(b)

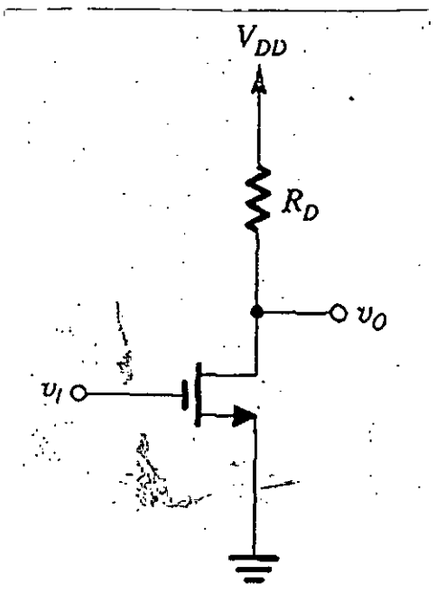

Fig. for Question no 1(b)

2. (a) The transistor shown in the figure below has V_t = 1.5 V, k_n (W/L) = 0.3 mA/V^2 and the early voltage is 100 V. The capacitors used in this circuit are sufficiently large to act as short circuits at the signal frequencies of interest. **(20)**

(i) Draw the small signal equivalent circuit diagram for this circuit.

(ii) Identify the mode of operation of the MOSFET and calculate the DC bias current under this condition.

(iii) Calculate the output voltage gain and input resistance of this circuit.

(iv) What is the maximum allowable input voltage signal for this circuit to obtain a non-distorted AC output?

(v) Make necessary modifications to the circuit so that its DC bias current remains constant and at the same time it operates as a common-source amplifier during small-signal operation.

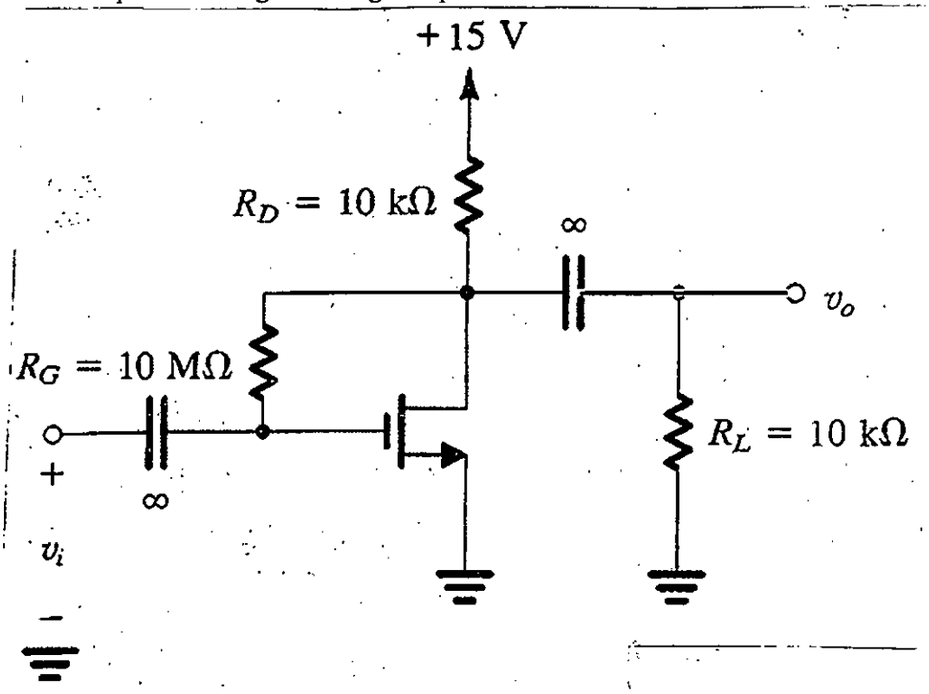

Fig. for Question no. 2(a)

Contd P/3

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Contd... Q. No. 2

(b) Draw the high-frequency equivalent circuit model of a MOSFET. Also show the frequency response of an amplifier circuit based on this MOSFET and mention which capacitors of this device and the circuit play dominant role in different frequency ranges of interest. **(15)**

3. (a) Derive the expression of voltage gain for the op-amp circuit shown in the figure below. What is the advantage of this circuit over that of a typical inverting amplifier circuit constructed using an op-amp? Explain with necessary expressions and circuit diagrams. **(20)**

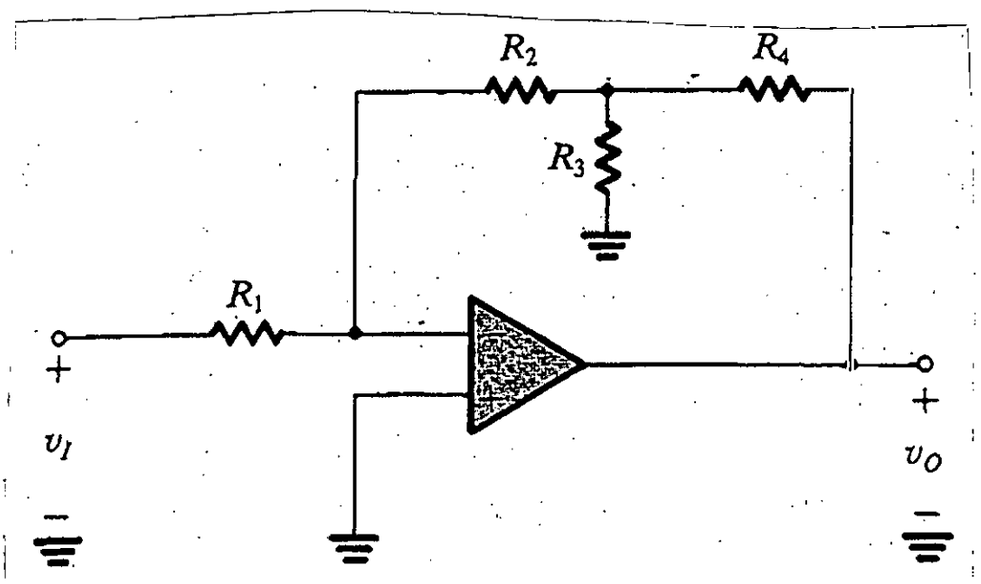

Fig. for Question no. 3(a)

(b) Suppose a biomedical signal consists of both low-and high-frequency components and all the useful information resides below the frequency of 1 kHz. Design an op-amp based filter circuit with the following specifications: the DC gain of the circuit should be 40 dB, cut-off frequency of the circuit should be 1.2 kHz and input resistance of the circuit should be 10 kΩ. **(15)**

4. (a) Consider the schematic shown in Fig. for Question no 4(a). The amplitude of the biomedical signal (v_{sig}) mentioned here varies from 0 to 100 mV. Using necessary number of op-amps, design a circuit which would result in the following outputs. **(15)**

- Only LED 1 will light ON when amplitude of v_{sig} is between 20 - 40 mV
- Both LED 1 and LED 2 will light ON when v_{sig} is between 41 - 60 mV
- LED 1, LED 2 and LED 3 will light ON when v_{sig} is between 61 - 80 mV
- All the LEDs will light ON when v_{sig} is between 81 - 100 mV

Assume that the minimum voltage required for any LED to light ON is 3V.

Contd P/4

EEE 273/BME

Contd... Q. No. 4(a)

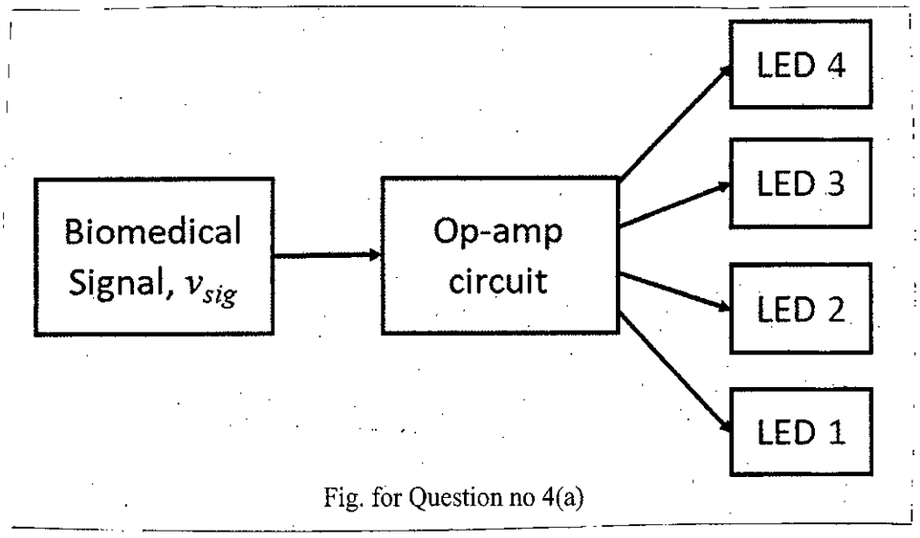

Fig. for Question no 4(a)

(b) Using the minimum number of op-amps possible, design a circuit which will result in the following output voltage, **(12)**

$$V_0 = 5V_1 - 7V_2 + 2.5V_3 - 5.5V_4$$

Here V_1, V_2, V_3 and V_4 are independent input voltages having a common ground.

(c) With necessary equations and circuit diagrams, show how you can perform integration and differentiation operations using op-amps. **(8)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Design a circuit that has the transfer characteristics as shown in Fig. for Q. 5(a). Assume that you have ideal diodes, resistors and dc voltage source. **(17)**

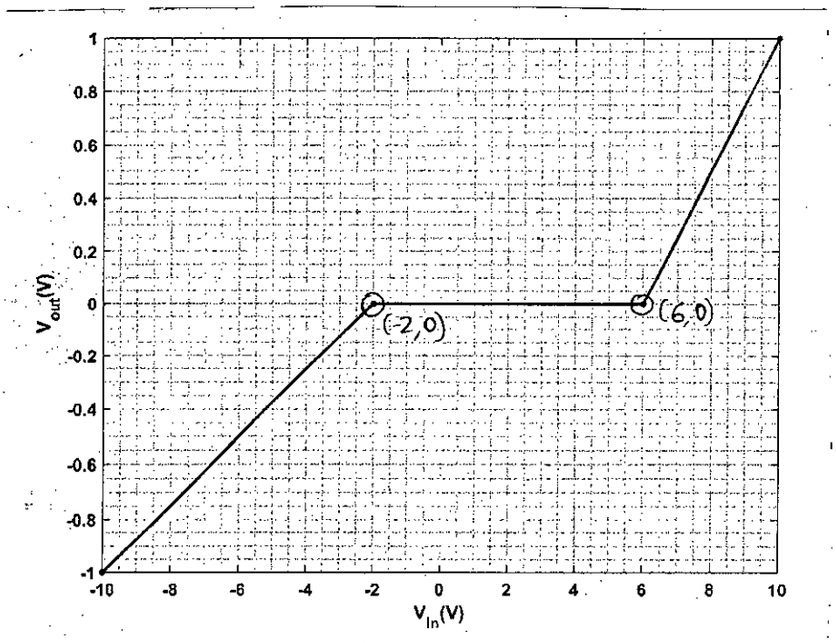

Fig. for Q. 5(a)

Contd P/5

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Contd... Q. No. 5

(b) A full-wave bridge rectifier circuit with a 1-kΩ load operates from a 120-V (rms) 60-Hz household supply through a 10-to-1 step-down transformer having a single secondary winding. It uses four diodes, each of which can be modeled to have a 0.7-V drop for any current. **(18)**

(i) What is the peak value of the rectified voltage across the load?

(ii) For what fraction of the cycle does the diode conduct?

(iii) What is the average output voltage?

(iv) What is the average current in the load?

6. (a) A zener shunt regulator shown in Fig. for Q. 6(a) employs a zener diode for which $V_z = 9.1\ V$ at $I_z = 9\ mA$, with $r_z = 30\ \Omega$ and $I_{zk} = 0.3\ mA$. The available supply voltage of 15 V can vary as much as ±10%. **(20)**

(i) What is the value of V_{zo} for this diode?

(ii) For a nominal load resistance R_L of 1 KΩ and a nominal zener current of 10 mA, what current must flow in the supply resistor R?

(iii) For a ±10% change in the supply voltage, what variation in output voltage results?

(iv) If the load current is reduced by 50%, what increase in output voltage results?

(v) What is the smallest value of load resistance that can be tolerated while maintaining regulation when the supply voltage is low?

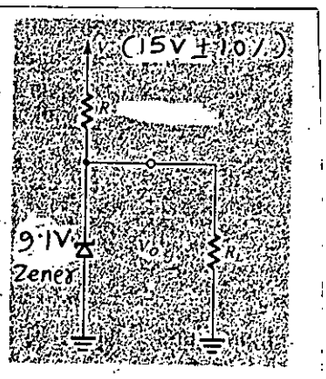

Fig. for Q. 6(a)

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Contd... Q. No. 6

(b) Assuming the diodes to be ideal, find the values of I and V in the circuit of Fig. for Q. 6(b). **(15)**

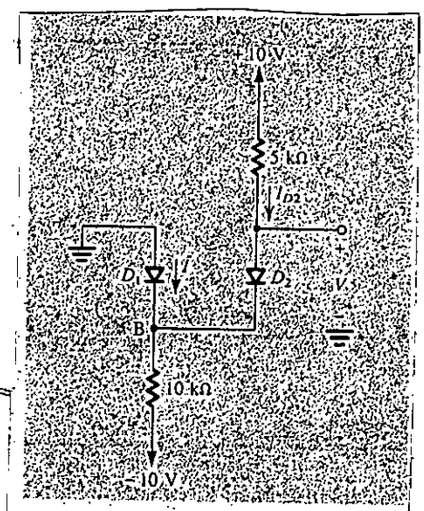

Fig. for Q. 6(b)

7. (a) Analyze the circuit of Fig. for Q. 7(a) and determine the voltages at all nodes and current through all branches. Assume the Si transistor has β =100. **(17)**

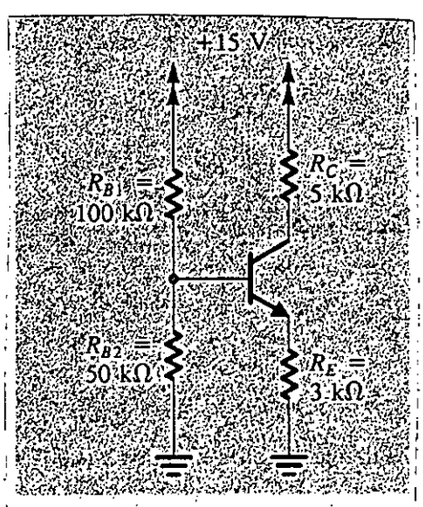

Fig. for Q. 7(a)

Contd P/7

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Contd... Q. No. 7

(b) Measurement indicates that the emitter voltage of the Si transistor in the circuit shown in Fig. for Q. 7(b) is 1.2 V. Assuming $|V_{BE}| = 0.7V$ find the values V_B, I_B, I_C, I_E, V_C, α and β. **(18)**

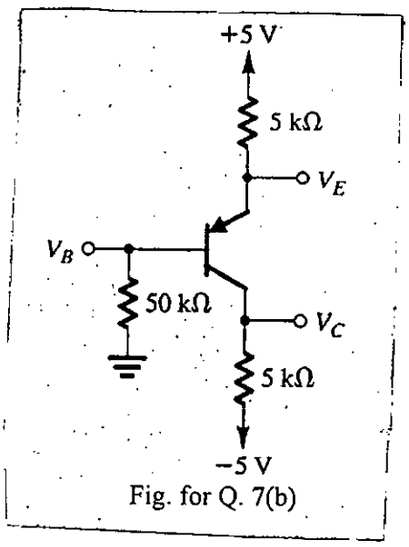

Fig. for Q. 7(b)

8. (a) For the common-emitter amplifier shown in Fig. for Q. 8(a), let V_{cc} = 15 V, R_1 = 27 kΩ, R_2 = 15 kΩ, R_E = 2.4 kΩ, and R_C = 3.9 kΩ. The Si transistor has β = 100. Calculate the dc bias current I_C. If the amplifier operates between a source for which R_{sig} = 2 kΩ and a load of 2 kΩ find the values of the input resistance, output resistance, current gain $\frac{i_o}{i_i}$ and overall voltage gain. **(20)**

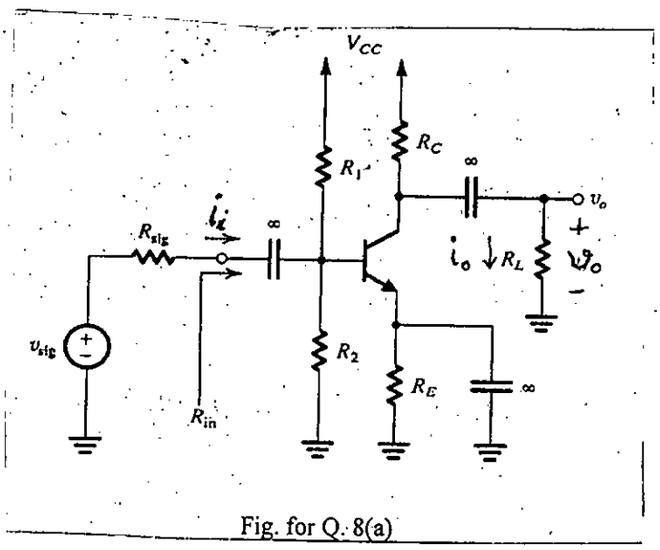

Fig. for Q. 8(a)

(b) Draw the frequency response curve of the common emitter amplifier and describe the three distinct bands that can be observed in the frequency response. **(15)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CSE 281** (Computer Programming)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Write a C function **isMultdentity** with proper parameters that takes two 3 × 3 matrices as parameters and returns 1 if multiplication of these matrices produces an identity matrix and 0 otherwise. An identity matrix contains 1s along its main diagonal and 0 in all other cells. You don't need to write the main function, and you don't need to scan any number from the user. **(15)**

1	0	0
0	1	0
0	0	1

Identity

1	1	0
0	1	1
0	0	1

Not Identity

(b) Write a C function **maxColumnSum** with proper parameters that takes two-dimensional array as input and returns the sum of the column with maximum sum. You don't need to write the main function, and you don't need to scan any number from the user. For example, the function will return 24 (sum of 6, 9, and 9) for the following array: **(10)**

4	6	2	5
7	9	4	8
6	9	3	7

(c) Write a C function **isSparseMatrix** with proper parameters that takes a matrix as parameter and checks whether the matrix is sparse or not. Sparse matrix is a matrix with the majority of its elements equal to zero. If the matrix is sparse then the function will return 1 otherwise 0. You don't need to write the main function, and you don't need to scan any number from the user. **(10)**

10	20	0
0	0	0
0	30	0

Sparse

10	0	0
0	20	30
0	40	50

Not Sparse

Contd P/2

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2. (a) Write a C program to sort an array of integers using the **selection sort** algorithm. You don't need to scan any number from the user. Show the steps of the selection sort algorithm for the following array: **(15)**

14, 33, 27, 10, 35, 19, 44, 42

(b) Write a complete C program using **recursion** that finds out the sum of digits of a given integer. **(10)**

(c) The following function searches the string needle in the string haystack and if successful returns the index in the haystack, otherwise returns -1. **(10)**

Int strsearch (char haystack [], char needle[])

Now write C code to implement the above function.

3. (a) Consider the following functions **(15)**

char * strncpy (char *s, char *t, int n) – copies n characters from t to s and returns s

char * strncat (char *s, char *t, int n) – concatenates n character from t to s and returns s

int strncmp (char *s, char *t, int n) – compares n character of s and t and returns 0/1

For example,

strncpy("hello", "123456", 3) returns "123"

strncat("hello", "123456", 4) returns "hello1234"

strncmp("hello", "helloworld", 5) returns 1

Write C implementation for the above functions using only pointer operations.

(b) Identify the problems of the following code segment: **(10)**

```
1   int main(){
2     int a;
3     int diff;
4     int *q;
5     double *p;
6
7     a = 10;
8     p = &a;
9     *p = 100;
10    *q = 10;
11    p = p + 2;
12    p = p - 2;
13    p = p * 1;
14    p = p/1;
15    diff = p -q
16    return 0;
17  }
```

You can use the line numbers (in the left) to identify problems if required.

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Contd... Q. No. 3

(c) Consider the following code: **(10)**

```
int main () {
    int N, i;
    printf("How many integers: ");
    scanf("%d", &N);
    int p[N];
    printf("Enter %d integers: ", N);
    for (i = 0; i < N; i++) {
        scanf("%d", &p[i]);
    }
    printf("Your integers: ");
    for (i = 0; i < N; i++) {
        printf("%d ", p[i]);
    }
    return 0;
}
```

Now rewrite the following code using **int *** instead of an array and use malloc and free whenever necessary.

4. (a) Consider students with following information: **(15)**

Id (int), Name (char), Bengali (float), English (float), Math (float), Science (float)

Define a C structure for student and write C code for the following:

(i) Load student information from a file name "students.txt" into your program. The "students.txt" file looks like

1, A, 80, 80, 100, 90

2, B, 70, 75, 90, 80

3, C, 50, 60, 70, 70

(ii) For each student find out the total marks and average. Write the information to a file name "summary.txt". The "summary.txt" will look like.

1, A, 350, 87.5

2, B, 315, 78.75

3, C, 250, 62.5

(iii) Write a C function that takes an array of the students as a parameter and returns the id of the student with maximum total marks.

You are not allowed to hard code only for 3 students.

(b) Write a complete C program that reads from a file named "in.txt" character by character and writes it to a file named "out.txt". **(10)**

Contd P/4

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Contd... Q. No. 4

(c) Consider the following C++ main function: **(10)**

```
int main () {
    Account a; // create an Account with initial balance of 1000
    a.setAccountNo(101); // set the account no to 101
    a.balance = 100; // this will give compile error for invalid access
    a.accountNo = 1002; // this will give compile error for invalid access
    a.debit(100); // deduct 100 from the balance
    a.credit(300); // add 300 to the balance
    a.print(); // print account no and balance
    return 0;
}
```

Now write C++ for the Account class for the above main function.

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Write a C program that will print the following sentence in the console: **(7)**

```
I Love CSE \ n
```

(b) Write a C program that will determine whether or not a point is on, inside, or outside a circle. The program will take as input the center co-ordinate and the radius of the circle, and then the co-ordinate of the said point. Note that you can only use standard input and output (**stdio.h**) library. Sample inputs and outputs are given below: **(15)**

Input	Output	Input	Output	Input	Output
3.00 4.00 5.00 0.00 0.00	ON	3.00 4.00 5.00 1.00 2.00	INSIDE	3.00 4.00 5.00 -3.00 -4.00	OUTSIDE

Table 1: Sample inputs and corresponding outputs for problem 5(b)

(c) Write a C program that will take as input three distinct integers a, b, and c and output their median value. You can only use **ternary conditional operators**. **(13)**

6. (a) Given two positive integers a and b as inputs, write a C program that will compute the following sum **(15)**

$$a-(a-1)+(a-2)^2-(a-3)^3+\ldots\pm(a-b)^b$$

Hint: You may nested loops.

Contd P/5

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Contd... Q. No.6

(b) Write a C program that will take as input the lengths of the three sides of a triangle and print whether or not the triangle is right (an angle is 90 degrees), acute (all angles less than 90 degrees), or obtuse (an angle is greater than 90 degrees). Sample inputs and outputs are given below: **(10)**

Input	Output	Input	Output	Input	Output
3.00 4.00 5.00	RIGHT	3.00 5.00 5.00	ACUTE	3.00 4.00 7.00	OBTUSE

Table 2: Sample inputs and corresponding outputs for problem 6(b)

(c) Write a C program that will take as input a single character and output the same character with its case changed (i.e. if it's in lowercase, output will be uppercase and vice-versa). **(10)**

7. (a) In this problem, you are given an algorithm to find the square root of a positive real number x. The idea works as follows: **(15)**

(i) You guess a random root, say r.

(ii) If $r * r$ is very close to x, you print the result and terminate.

(iii) Otherwise, you set $r \leftarrow \frac{1}{2}\left(r + \frac{x}{r}\right)$ and check condition (ii) again.

Now write a C program implementing the algorithm given x as input. You may initially set r to 1.00.

(b) You will be given as input an integer n, followed by a sequence of n lowercase characters. Write a C program that will print the second most frequent character in the sequence. [No input will have only one character.] **(10)**

(c) Given four integers as input, you have to write a C program to determine if any of their permutations forms an arithmetic sequence. A sequence is called arithmetic if the difference of consecutive elements is constant. Sample inputs and outputs are given below: **(10)**

Input	Output	Input	Output	Input	Output
2	YES	1	YES	2	NO
3		3		4	
4		7		6	
5		5		10	

Table 3: Sample inputs and corresponding outputs for problem 7(c).

8. (a) In probability theory and statics, mean and variance are the measures of central tendency and dispersion of data, respectively. Given n numbers $x_1, x_2, \ldots, x_n$, there mean is given by **(15)**

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i$$

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Contd... Q. No.8 (a)

and their variance by

$$\text{VAR} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2$$

Now write a C program that will first take as input an integer n, followed by n numbers, and output their mean and variance. You may use **arrays** to store those n numbers. Sample inputs and outputs are given below:

Input	Output
3	2
1.00 2.00 3.00	0.666667

Table 4: Sample inputs and corresponding outputs for problem 8(a).

(b) Solve the same problem above 8(a), without using any array. **Hint:** Try to simplify the formulae given above. **(5)**

(c) What will be the output of the following C program? Justify your answer. **(15)**

```
#include<stdio.h>
int main() {
    int i = 0;
    switch(i++) {
    case 0:
        switch(++i) {
        case 2:
            printf("A\n");
        case 3:
            printf("B\n");
        default:
            printf("C\n");
        }
        break;
    case 1:
        switch(++i) {
        case 2:
            printf("D\n");
        case 3:
            printf("E\n");
        default:
            printf("F\n");
        }
        break;
    default:
        printf("Invalid\n");
        break;
    }
    return 0;
}
```
