BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **BME 201** (Biomechanics)

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) Consider a person strengthening the shoulder muscles by means of dumbbell `exercises. Figure for question 1 illustrates the position of the arm when the arm is fully abducted to horizontal. The free-body diagram of the arm is also shown. Point O corresponds to the axis of rotation of the shoulder joint, point A is where the deltoid muscle is attached to the humerus, point B is the center of gravity of the entire arm, and point C is the center of gravity of the dumbbell. W is the weight of the arm, W_O is the weight of the dumbbell, F_M is the magnitude of the tension in the deltoid muscle, and F_J is the magnitude of the joint reaction force at the shoulder. The resultant of the deltoid muscle force, F_M makes an angle θ, and the joint reaction force, F_J makes an angle β with the horizontal. The distances between point O and point A, B, and C are measured as a, b, and c, respectively. Determine the magnitude of force F_M and the magnitude and direction of the force F_J. Consider, a= 15 cm, b = 30 cm, c = 60 cm, $\theta = 15°$, W = 40 N and W_O = 60 N. **(20)**

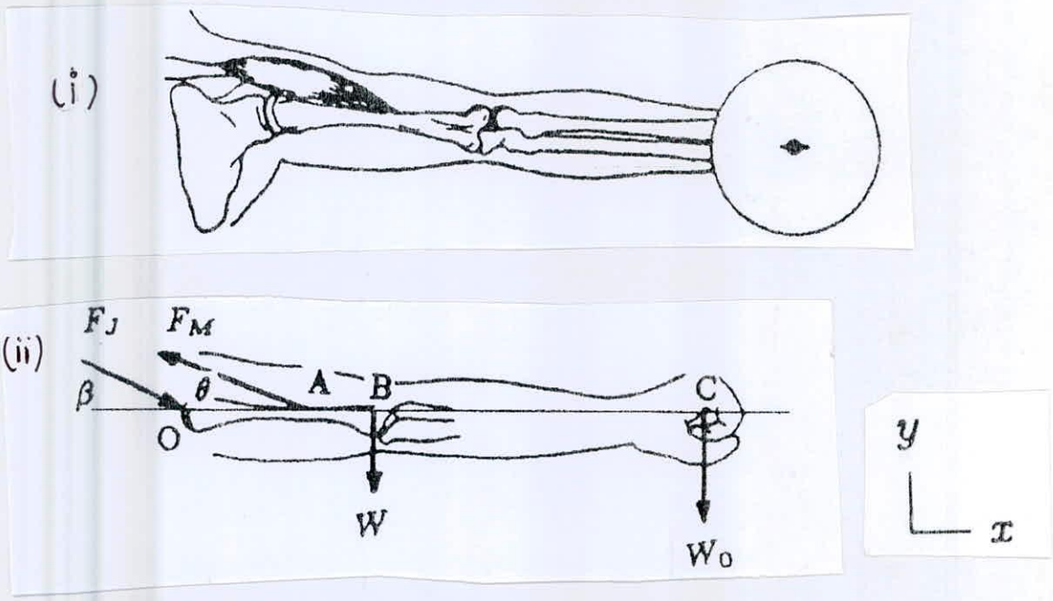

Figure for question 1(a)

Contd P/2

BME 201

Contd... Q. No. 1

(b) As illustrated in Figure for question 1(b), consider a simple traction device applied to the leg of a patient such that the cable of the pulley makes an angle $\alpha = 35°$ with the horizontal. The leg is in a cast and the coefficient of friction between the cast and the bed is $\mu = 0.45$. The weight of the leg is W = 180 N: Determine the tension in the cable. **(15)**

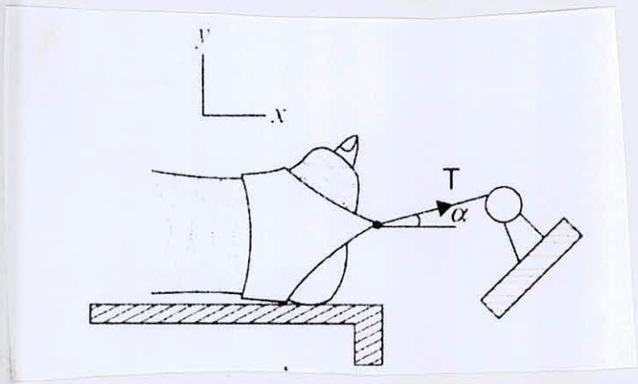

Figure for question 1(b)

2. (a) A man has a weight of 90 kg, and the coefficient of static friction between his shoes and the floor is $\mu_s = 0.5$ (Figure for question 2(a)). Determine where he should position his center of gravity G at d in order to exert the maximum horizontal force on the door. What is this force? **(15)**

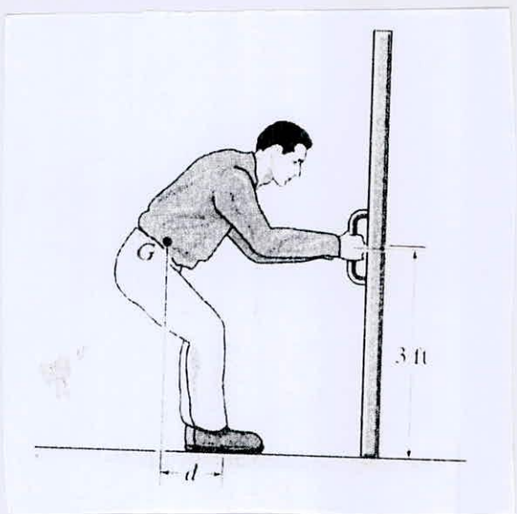

Figure for question 2(a)

(b) A girl throws a 0.5-kg ball toward the wall with an initial velocity $y_A = 10$ m/s (Figure for question 2(a)). Determine- **(6+6+8)**

(i) the velocity at which it strikes the wall at B,

(ii) the velocity at which it rebounds from the wall if the coefficient of restitution, e = 0.5,

(iii) the distance from the wall to where it strikes the ground at C.

Contd P/3

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Contd... Q. No. 2(b)

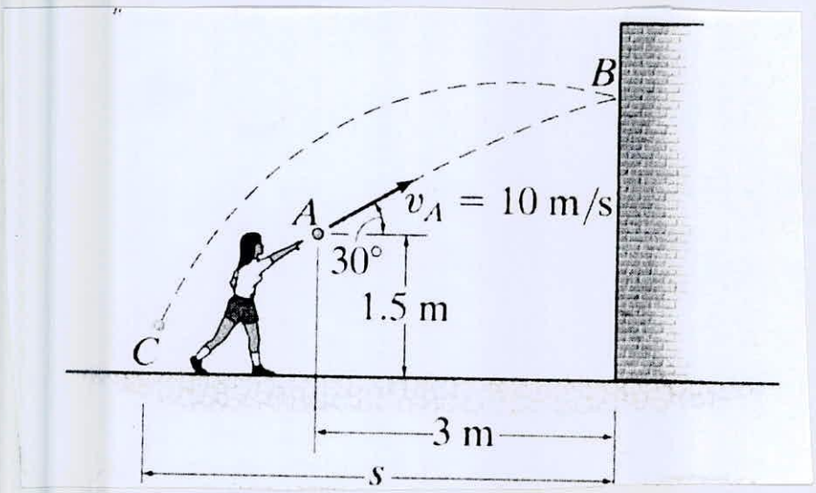

Figure for question 2(b)

3. (a) The human leg can be crudely approximated as two rigid bars (the femur and the tibia) connected with a pin joint (Figure for question 3(a)). At the instant shown, the velocity and the acceleration of the ankle A is zero, the tibia AK has an angular velocity of 1.5 rad/s counter-clockwise and an angular acceleration of 1 rad/s^2 counter-clockwise. Determine the relative angular velocity and relative angular acceleration of the femur KH with respect to AK so that the velocity and acceleration of H are both straight up at this instant. **(20)**

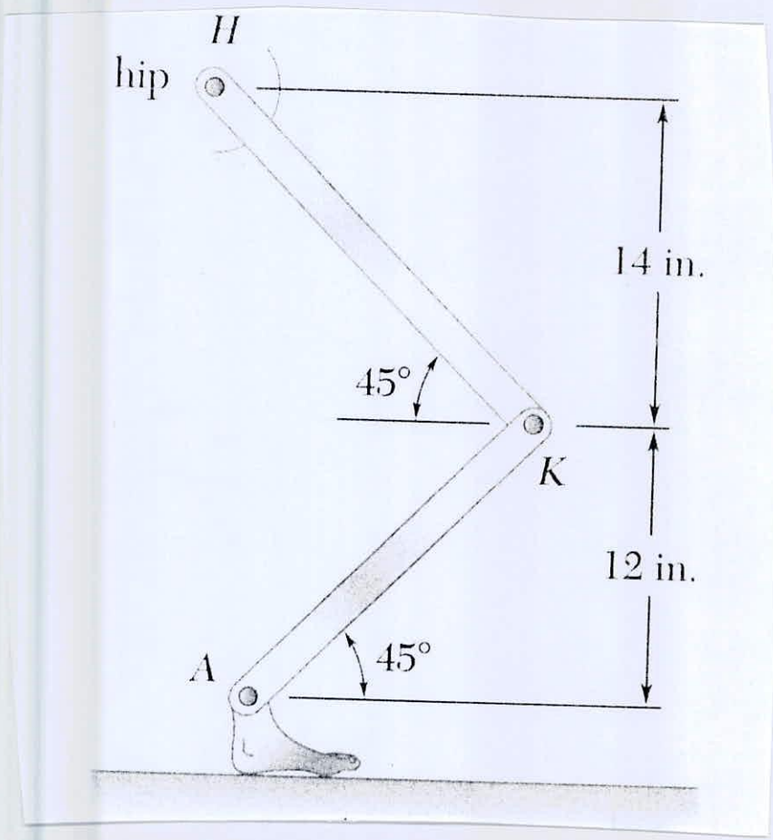

Figure for question 3(a)

Contd P/4

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Contd... Q. No. 3

(b) The 20-kg punching bag has a radius of gyration about its center of mass G of $k_G = 0.4$ m (Figure for question 3(b)). If it is initially at rest and is subjected to a horizontal force F = 30 N, determine the initial angular acceleration of the bag and the tension in the supporting cable AB. **(15)**

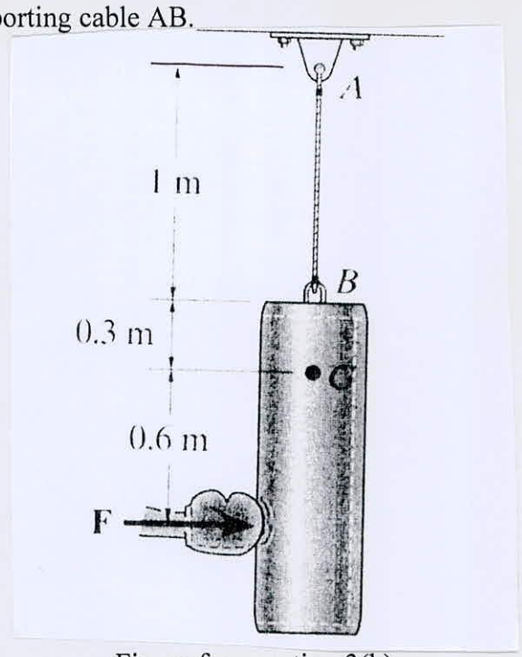

Figure for question 3(b)

4. (a) A person executes a standing jump from a platform. **(15+5)**

(i) Derive a formula for the maximum elevation of the jumper's center of gravity in terms of the crouch depth, c, the equivalent force to weight ratio, F_{equiv}/W, and other relevant parameters.

(ii) If the crouch depth is 18 inches and the ratio F_{equiv}/W is 2, compute the elevation of the center of gravity.

(b) Consider the leg shown in Figure for question 4(b), which is flexed to a right angle. The coordinates of the centers of gravity of the leg between the hip and knee joints (upper leg), the knee and ankle joints, and the foot, as measured from the floor level directly in line with the hip joint, are given in Table for Question 4(b). The weights of the segments of the leg as percentages of the total weight W of the person are also provided in Table 4(b). Determine the location of the center of gravity of the entire leg. **(15)**

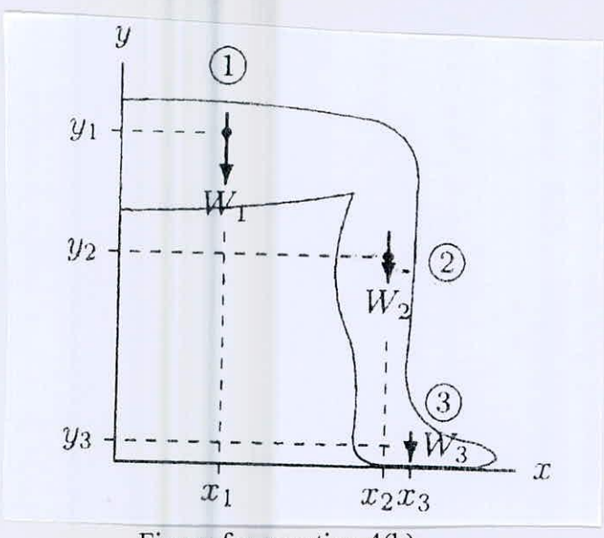

Figure for question 4(b)

PART	X (CM)	Y (CM)	% W
1	17.3	51.3	10.6
2	42.5	32.8	4.6
3	45.0	3.3	1.7

Table for Question 4(b).

Contd P/5

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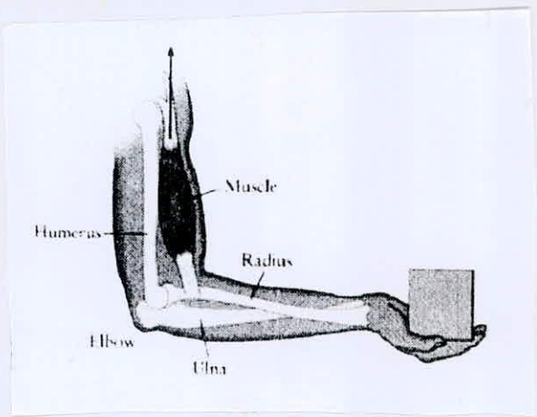
SECTION – B

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

5. (a) Suppose a book of 6 kg mass is distributed uniformly over the distance 6 cm of your hand (Figure for question 5(a)). An equivalent schematic diagram with necessary muscle forces and the muscle insertion distances are shown in the figure. **(26)**

   (i) Draw the shear force diagram and bending moment diagram for the hypothetical beam shown in the figure.

   (ii) Suppose the proximal end of the beam where there is a hinge joint, is replaced by a fixed joint. What is the name of this kind of beam? How can we use this kind of beam in high resolution cellular imaging or mechanobiological measurement?



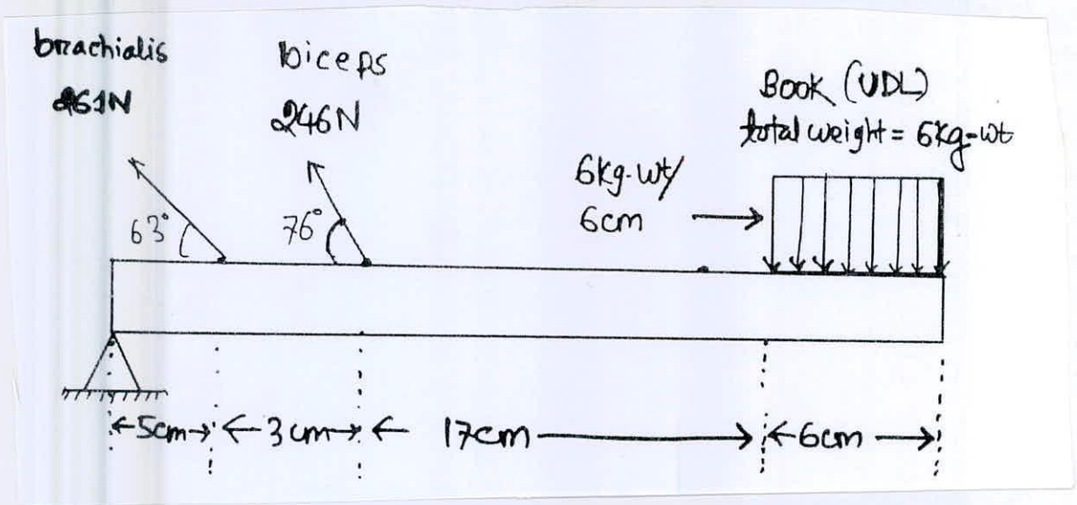


Figure for Question 5(a)

(b) What total axial force can be generated by a pinnate muscle having the form and dimensions shown in the Figure for question 5(b)? The force, f, developed by muscle per unit cross-sectional area may be taken as 20 N/cm^2. **(9)**

Contd P/6

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Contd... Q. No. 5(b)

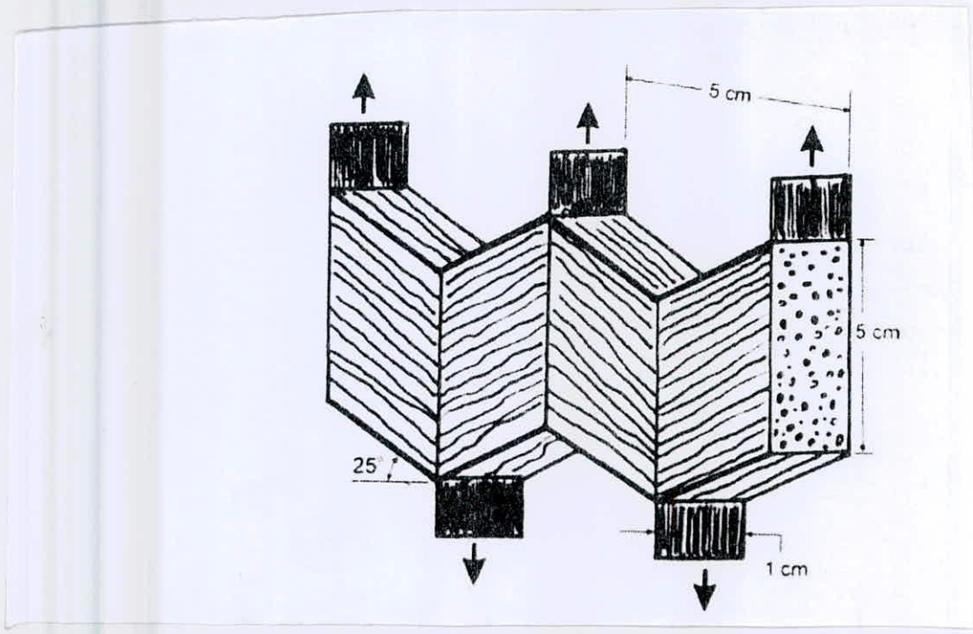

Figure for Question 5(b)

6. (a) A human femur is mounted in the grips of the torsion testing machine as shown in the figure. The length of the bone at sections between the rotating (D) and stationary (E) grips is measured as L = 37 cm. The femur is subjected to only torsional loading until fracture at section aa, which is 1 = 25 cm from the stationary grip. The cross-section of the bone shows it is an annular shape with inner hollow radius, r_i = 7 mm, and outer radius, r_0 = 13 mm. The applied torque versus angular displacement (deflection) graph shown in the Figure for question 6(a) is also obtained. **(21)**

(i) Calculate the shear modulus of elasticity (G).

(ii) Calculate torsional stress, torsional rigidity, and torsional energy.

(iii) Here if the fracture occurs at the orientation of the principal plane, draw a Mohr's circle to determine how much (in degree unit) rotation does the bone need to undergo to get fractured.

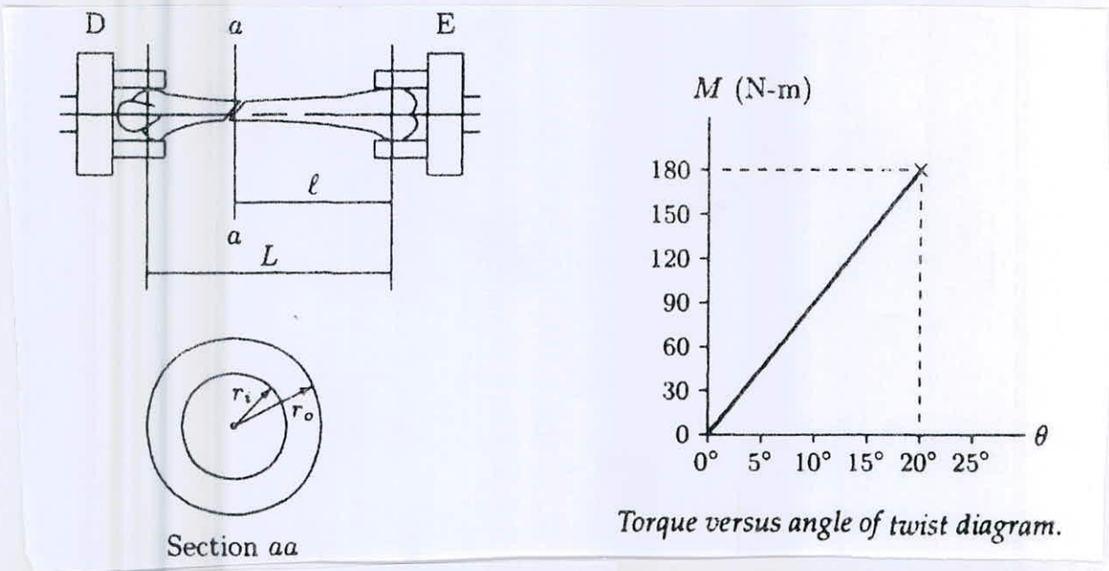

Figure for Question 6(a)

Contd P/7

BME 201

Contd... Q. No. 6

(b) Compare between different regions of engineering stress-strain curve and true stress-strain curve. Hence, derive the relationship between engineering strain and true strain. **(9)**

(c) Why do sedentary people lose relatively higher bone mass than active people? **(5)**

7. (a) Polymeric screws are used for biomedical applications like- ACL replacement surgery. It shows visocelastic behavior which can be modeled as Kelvin-Voigt model. If it shows creep-recovery behavior like the Figure for question 7(a), then find the time it requires to reach half of the maximum strain in the creep phase. **(10)**

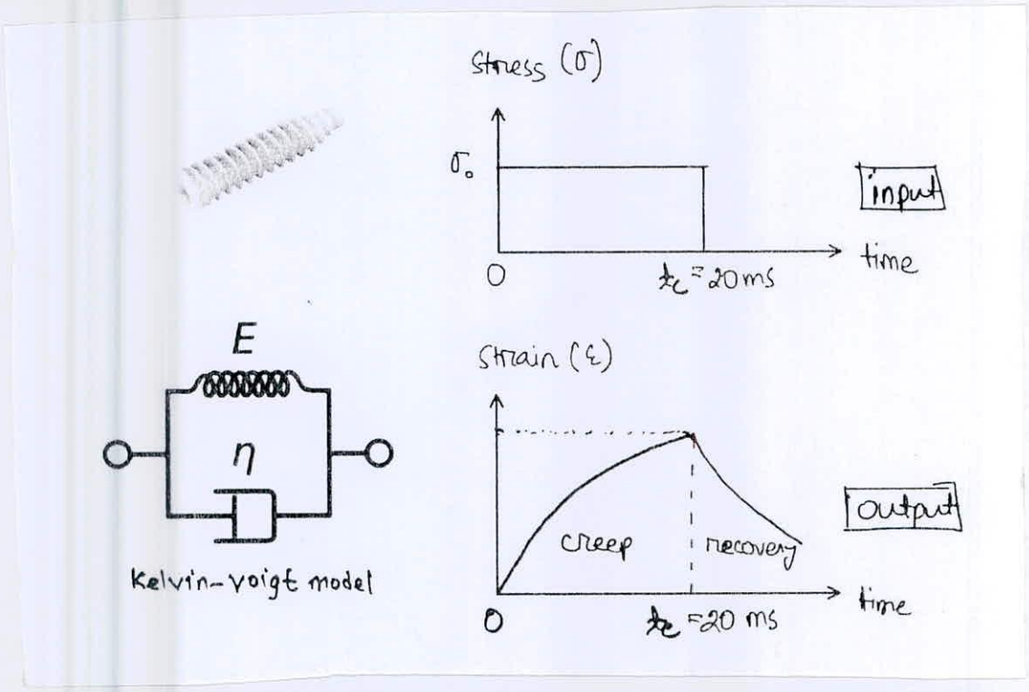

Figure for Question 7(a)

(b) Name the elements that are required to model a muscle mathematically. Derive the mathematical muscle model for isometric contraction using these elements to show that the graph has one growth region and one decay region. **(17)**

(c) Graphically explain, how the crimp pattern of collagen structure plays a vital role to determine the mechanical properties of tendon and ligament? **(8)**

8. (a) A tibial plateau made of modified UHMWPE (Young's modulus = 1 GPa, Poisson's ratio = 0.4, and Uniaxial Yield Strength = 8 MPa) in a rigid frame of CoCr alloy is shown int he Figure for question 8(a). Given a load of 30 kN on z axis evenly spread across the xy plane of the tibial plateau, will it undergo failure according to von Misses failure criterion? If not, then what will be the Factor of Safety (FOS)? **(15)**

Contd P/8

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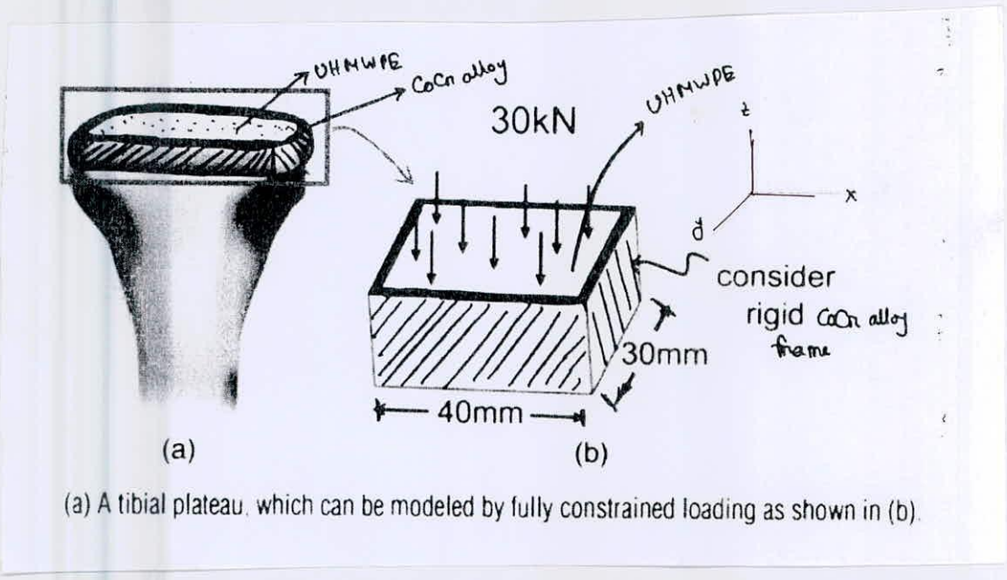
Contd... Q. No. 8(a)



(a) A tibial plateau, which can be modeled by fully constrained loading as shown in (b).

Figure for Question 8(a)

(b) Consider a cemented metallic femoral stem that is isotropic and is subjected to a multiaxial sress state as shown in the figure. **(20)**

(i) Draw a Mohr's circle to find the principal stresses and orientation of principal plane when the system is unrotated.

(ii) Verify the values you obtained in question (i) using analytical method (using formula).

(iii) If the system is rotated 30° anti-clockwise as in the Figure for question 8(b) (use traditional convention for sign), find the new normal and shear stresses using Mohr's circle.

(iv) Verify the values in question (iii) using both analytical method (using formula) and stress tensor (using Eigen value) method.

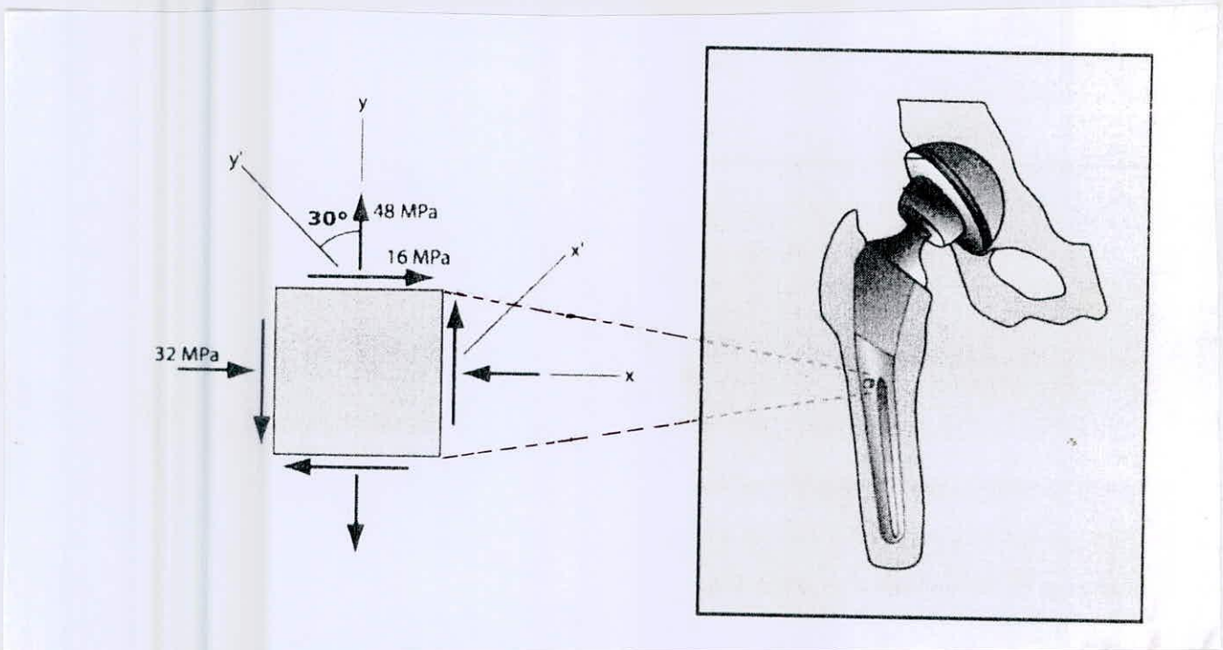


Figure for Question 8(b)

L-2/T-1/BME **Date: 30/03/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2020-2021

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

Symbols used have their usual meaning.

SECTION – A

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

1. (a) The Shroud of Turin, which shows the negative image of the body of a man who appears to have been crucified, is believed by many to be the burial shroud of Jesus of Nazareth. In 1988, the Vatican granted permission to have the shroud carbon-dated. Three independent scientific laboratories analyzed the cloth and concluded that the shroud was approximately 660 years old, an age consistent with its historical appearance. **(15)**

   (i) Write down the first-order differential equation for the above carbon dating problem mentioning each term precisely.

   (ii) Using the abovementioned age, determine what percentage of the original amount of C-14 remained in the cloth as of 1988.

   (b) A large tank is filled to capacity with 800 gallons of pure water. Brine containing 2 pounds of salt per gallon is pumped into the tank at a rate of 8 gal/min. The well-mixed solution is pumped out at the same rate. **(15)**

   (i) Formulate the corresponding ordinary differential equation of the above scenario mentioning each information mathematically.

   (ii) Find the number A(t) of pounds of salt in the tank at time t.

   (c) Discuss the role of "direction field or slope field" with examples in terms of understanding qualitative aspects of solution curves. **(5)**

2. (a) Check whether the differential equation $(3x^2y^4+2xy)dx+(2x^3y^3-x^2)dy=0$ is exact or not. If not, then reduce it into exact form and hence solve. **(10)**

   (b) Solve the following differential equations: **(20)**

   (i) $\frac{dy}{dx}+x\sin 2y=x^3\cos^2 y$

   (ii) $\frac{dy}{dx}=(-2x+y)^2-7,\ y(0)=0$.

   (c) Discuss the role of "integrating factor" in terms of solving ordinary differential equations. **(5)**

Contd P/2

3. (a) A mass weighing 24 pounds, attached to end of a spring, stretches it 4 inches. Initially, the mass is released from rest from a point 3 inches above the equilibrium position. **(15)**

   (i) Formulate the corresponding ordinary differential equation of the above scenario mentioning each information mathematically.

   (ii) Determine the equation of motion.

   (iii) What are the amplitude and period of motion?

   (b) Find complementary function and particular integral of the following differential equations: **(10)**

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

   (c) Solve the differential equation: **(10)**

$$x^3\frac{d^3y}{dx^3} + 5x^2\frac{d^2y}{dx^2} + 7x\frac{dy}{dx} + 8y = 0.$$

4. (a) Solve the following differential equation by the method of factorization of operators: **(15)**

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

   (b) Solve the following differential equations: **(20)**

   (i) $\frac{d^2y}{dx^2} + 2y\left(\frac{dy}{dx}\right)^3 = 0.$

   (ii) $x^2\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0.$

SECTION – B

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

5. (a) Find the series solution of the following differential equation by using the method of Frobenius: **(25)**

$$4x\frac{d^2y}{dx^2} + 2(1-x)\frac{dy}{dx} - y = 0.$$

   (b) Form a partial differential equation by eliminating the arbitrary function ϕ from **(10)**

$$\phi\left(\tan x + \sin^{-1} y - \log z, e^x - \sec y + z^3\right) = 0.$$

MATH 213/BME

6. (a) Apply Lagrange's auxiliary equation technique to solve: **(10)**

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

(b) Using Charpit's method find the complete integral of the following partial differential equations: **(13+12=25)**

(i) $pxy+pq+qy-yz=0$.

(ii) $p^2-y^2q-y^2+x^2=0$.

7. Solve the following higher order partial differential equations:

(a) $\left(D_x^2-D_xD_y-6D_y^2\right)z=xy$. **(11)**

(b) $\left(D_x^2+3D_y-2D_x\right)z=\left(x^2+2y^2\right)e^{2x+y}$. **(12)**

(c) $(D_x+1)(D_x+D_y-1)z=\sin(x+2y)$; where $D_x=\frac{\partial}{\partial x}$ and $D_y=\frac{\partial}{\partial y}$. **(12)**

8. (a) Solve the following higher order partial differential equation: **(15)**

$$x^2\frac{\partial^2 z}{\partial x^2}-4y^2\frac{\partial^2 z}{\partial y^2}-4y\frac{\partial z}{\partial y}-z=x^3y^2\log x.$$

(b) Solve the following boundary value problem by the method of separation of variables **(20)**

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2},\ u(0,t)=0=u(4,t),$$

$$u(x,0)=6\sin\frac{\pi x}{2}+3\sin\pi x.$$

L-2/T-1/BME **Date : 24/03/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2020-2021

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**.

1. (a) From the following demand function, make a hypothetical demand schedule and plot the curve. (10)

$$Q = 100 - 20P + P^2$$

(b) What are the main causes of shifting of the demand curve? Explain. (15)

(c) Why do demand curves generally slope downward? (10)

2. (a) How would you measure price elasticity of demand at any point of a straight line demand curve? Explain graphically. (20)

(b) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result. (15)

POINT	P_y	Q_x
A	1500	50
B	1600	60
C	1700	70

3. (a) Explain the properties of an indifference curve. (20)

(b) Explain consumer's equilibrium with the help of budget line and indifference curve. (15)

4. (a) How is price determined in an economy under competition? What will happen to the price and quantity due to change in demand? (15)

(b) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph. (20)

$$P = 0.50\,Q + 150$$

$$P = -0.40\,Q + 300$$

(i) What will happen to the equilibrium price and quantity if government imposes a unit tax of Tk 2 per unit?

(ii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

Contd P/2

HUM 241/BME

SECTION – B

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

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

   (b) Explain the long run equilibrium of a firm under perfect competition. (15)

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

   $R = 1200Q - 2Q^2$

   $C = Q^3 - 61.25Q^2 + 1538.5Q + 2000$

6. (a) Given $Y = C+I+G$, $C = C_0 - bY$, $I = I_0$, and $G = G_0$, where $C_0 = 135$, $b = 0.7$, $I_0 = 75$, and $G_0 = 30$. Find the equation for the equilibrium level of income. Solve for the equilibrium level of income and show it graphically. (20)

   (b) Two identical countries, Country A and Country B. The MPC is 0.8 in each country. Country A decides to increase spending by $ 5 billion, while Country B decides to cut taxes by $ 5 billion. In which country will the new equilibrium level of income be greater? (15)

7. (a) Using the following table create Consumer Price Index (CPI) in 2017, 2018, 2019 and 2020 (Currency in Taka). (20)

Product	Base Year (2010) Quantity	Base Year (2010) Per Unit Price	2017 Expenditures (on base-year quantities)	2018 Expenditures (on base-year quantities)	20179 Expenditures (on base-year quantities)	2020 Expenditures (on base-year quantities)
Vaccination	10	500	1000	1500	2000	2500
Masks	20	50	1500	2000	2700	10000
Hand sanitizer	15	20	400	600	900	5000
Pulse Oximeter	500	10	9000	10000	12000	30000
Books	30	100	5000	7000	8000	20000
Lemons	100	4	800	900	1200	3000

   (b) Using the CPI you created in question, calculate inflation rate from 2017 to 2018, from 2018 to 2019, and from 2019 to 2020. (15)

8. (a) Write short notes on Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). (20)

   (b) Explain and show graphically the effects of "cost push inflation" and "demand pull inflation" on the economy. (15)

L-2/T-1/BME **Date: 13/4/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2020-2021

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.

The symbols have their usual meanings. Assume reasonable values for any missing data.

1. (a) The NMOS transistors in the circuit shown in Fig. for Q. No. 1(a) have threshold voltage of 0.5 V, process transconductance parameter of 250 $\mu A/V^2$ and length $L_1 = L_2 = 0.25$ μm. Neglect channel length modulation. Find the required values of gate width for each of the transistors and the value of R, to obtain the voltage and current values indicated. **(15)**

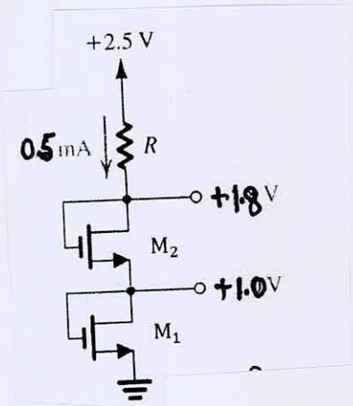


Fig. for Q. No. 1(a)

(b) Determine the small signal voltage gain of the PMOS transistor circuit shown in Fig. for Q. No. 1(b). The transistor parameters are $k_p = 800\ \mu A/V^2$, $V_{tp} = -0.5$ V. Neglect channel length modulation. **(20)**

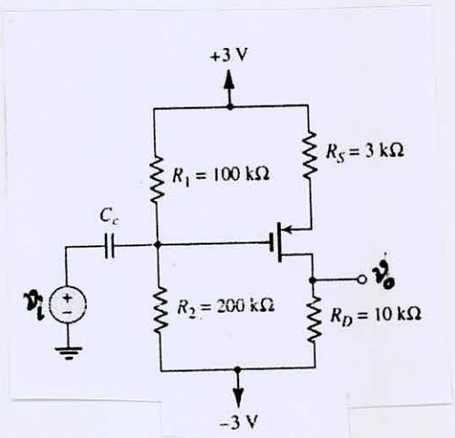


Fig. for Q. No. 1(b).

Contd P/2

EEE 273/BME

2. Identify the two MOS amplifier structures shown in Fig. for Q. No. 2. Draw the small signal equivalent circuit and find its overall voltage gain, input resistance and output resistance. The NMOS transistors have V_t = 1.2 V, k_{n1} = 500 μA/V^2, k_{n2} = 200 μA/V^2. Neglect channel length modulation. **(35)**

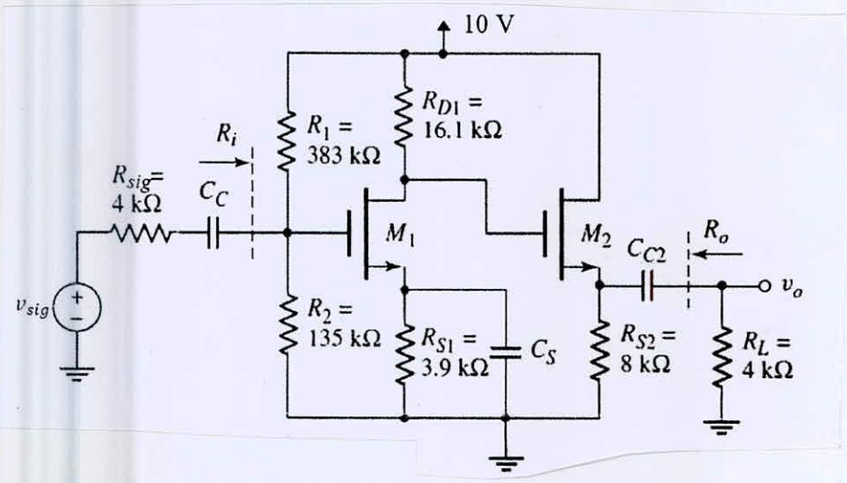


Fig. for Q. No. 2

3. (a) Consider the ideal op-amp circuit shown in Fig. for Q. No. 3(a). **(25)**

(i) Derive the closed-loop voltage gain expression of the circuit.

(ii) Design the circuit to have a voltage gain of -75 and input resistance of 20 kΩ. The maximum resistor value is to be limited to 200 kΩ.

(iii) What is the current gain of your design amplifier circuit?

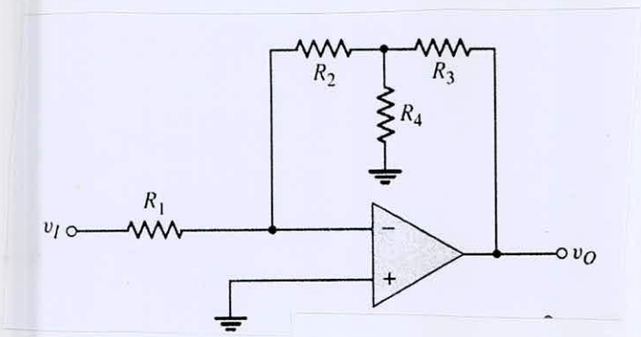


Fig. for Q. No. 3(a)

(b) Design a circuit that would convert a symmetrical square wave signal of 20 V peak-to-peak, 0 average, and 2 ms time period to a triangular waveform signal with 20 V peak-to-peak amplitude. **(10)**

4. (a) In the circuit shown in Fig. for Q. No. 4(a) find V_1,V_2, V_3 and the power dissipated in each of the transistors. The two transistors M1 and M2 have a threshold voltage of 1V, process transconductance parameter of 125μA/V^2 and aspect ratio of 20 and 30, respectively. **(20)**

Contd P/3

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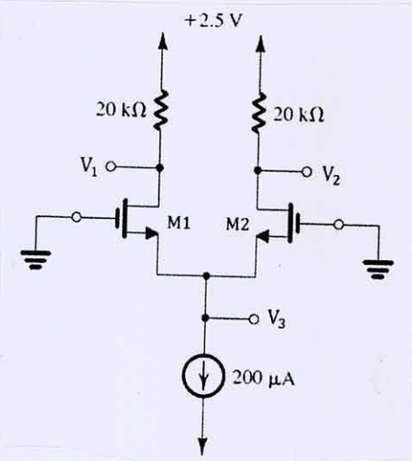

Fig. for Q. No. 4(a)

(b) Design a circuit using ideal operational amplifiers that would implement the following equation: $v_o \infty \frac{d}{dt}(v_1 - v_2)$. Write the final output expression in-terms of the circuit components used in your design. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.
The symbols have their usual meaning.

5. (a) Consider the circuit shown in Fig. for Q. No. 5(a). Here the input voltage is sinusoidal signal having peak-to-peak voltage of 10 V and frequency of 20 Hz. The diode shown here has a constant voltage drop of 0.7 V when it is forward biased. **(18)**

(i) Calculate the peak output voltage v_o.

(ii) If the polarity of the diode is reversed, will it conduct during positive or negative half-cycle of the input sinusoidal signal? Justify your answer with necessary calculations.

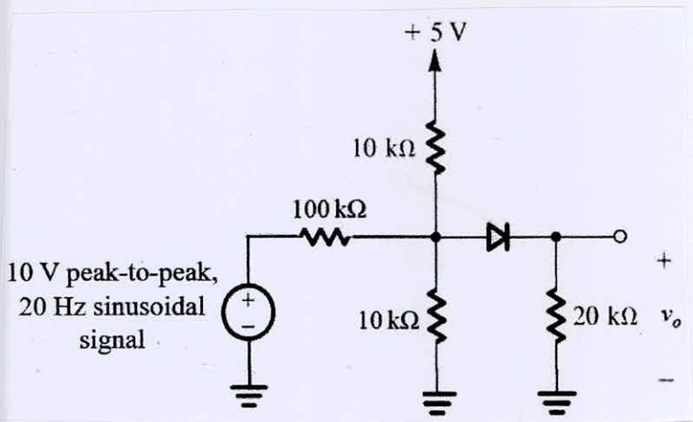

Fig. for Q. No. 5(a)

(b) Draw the circuit diagram of an n-p-n BJT based emitter-follower circuit with necessary connections for biasing and AC small-signal input. Also derive the expression of its voltage gain based on its small signal equivalent circuit model. What are the advantages of this circuit compared to the common-emitter amplifier circuit? **(17)**

Contd P/4

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6. (a) Consider the circuit shown in Fig. for Q. No. 6(a). Here, Zener Diode 1 has $V_z = 6$ V at $I_z = 10$ mA, $r_z = 20\ \Omega$ and $I_{ZK} = 0.4$ mA, whereas Zener Diode 2 has $V_z = 6.8$ V at $I_z = 5$ mA, $r_z = 20\ \Omega$ and $I_{ZK} = 0.4$ mA. Here different symbols have their relevant meanings. **(20)**

Calculate the minimum value of load resistor R_L so that both diodes operate in the breakdown region. Also calculate the output voltage (v_o) of the circuit if a load resistor of $R_L = 4$ kΩ is connected at the output.

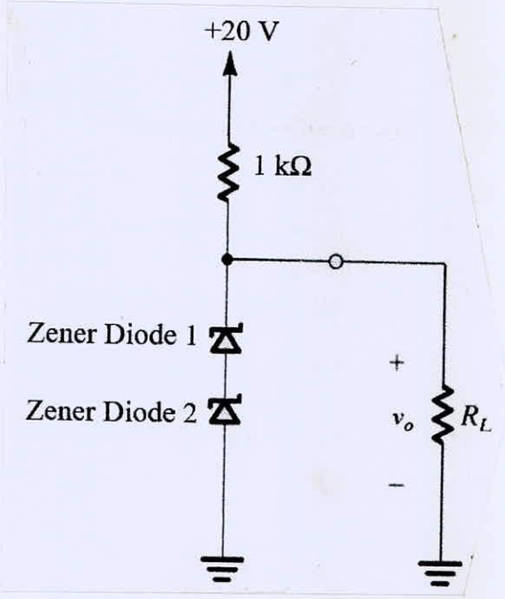

Fig. for Q. No. 6(a)

(b) Consider the circuit shown in Fig. for Q. No. 6(b). For both BJTs, the nominal value of β is 100, and the minimum value of β is 30. Calculate the collector currents of both BJTs. Also calculate the voltage appearing across the 1 kΩ load resistor. **(15)**

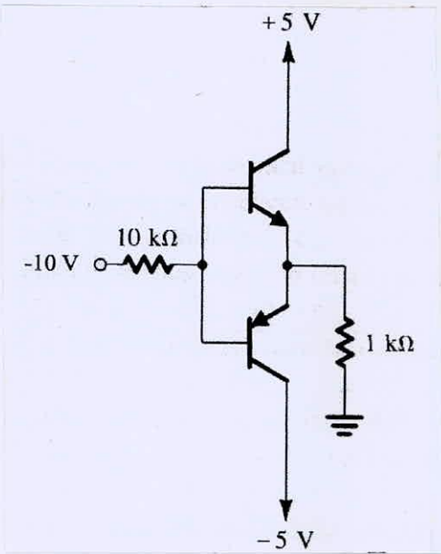

Fig. for Q. No. 6(b)

7. (a) Consider the circuit shown in Fig. for Q. No. 7(a), where both BJTs have $\beta = 100$. For a particular application, it is necessary that both BJTs operate in active mode and the p-n-p BJT has +7.4 V at its collector node. Calculate the value of R_C to achieve this operating condition. **(20)**

Contd P/5

Contd... Q. No. 7(a)

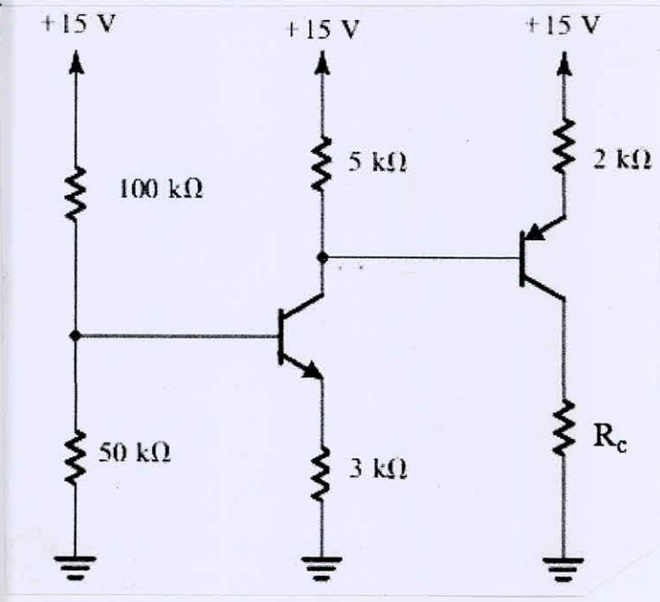

Fig. for Q. No. 7(a)

(b) Draw the circuit diagram of full-wave bridge rectifier circuit with a filter capacitor. Based on your circuit, qualitatively draw waveforms for the following cases. **(15)**

(i) Output voltage waveform when a square wave pulse is given as the input.

(ii) Output voltage waveform when a sinusoidal signal is given as the input.

(iii) Assume that one of the diodes of the circuit has become dysfunctional for some reason and this diode always behaves as an open circuit. Draw the output waveform of the circuit under this condition for a sinusoidal input.

8. (a) Consider the circuit shown in Fig. for Q. No. 8(a), where v_i is a small biomedical signal. The BJT has a β value of 100. Neglecting early effect, calculate the following. **(20)**

(i) Output voltage at the collector terminal of the BJT when v_i = 100 mV

(ii) Maximum value of input voltage v_i so that the BJT operates in active mode

Suppose because of temperature change, β of the BJT has changed to 70. Calculate the output voltage under such condition. What modification would you suggest to the circuit so that it becomes less sensitive to the variation of β; draw your proposed circuit diagram.

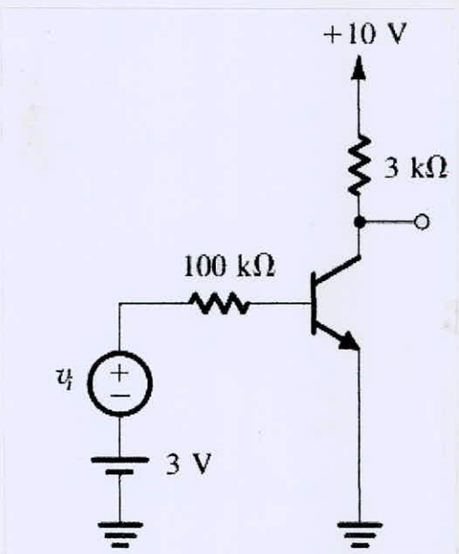

Fig. for Q. No. 8(a)

Contd P/6

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Contd... Q. No. 8(b)

(b) Consider the circuit shown in Fig. for Q. No. 8(b). Calculate the output voltage (v_0) for the following cases. **(15)**

(i) Assuming the diodes to be ideal, obtain output voltage (v_0) for an input voltage of v_i = -5 V

(ii) Assuming the diodes to have a constant voltage drop of 0.7 V, obtain output voltage (v_0) for an input voltage of v_i = 7 V.

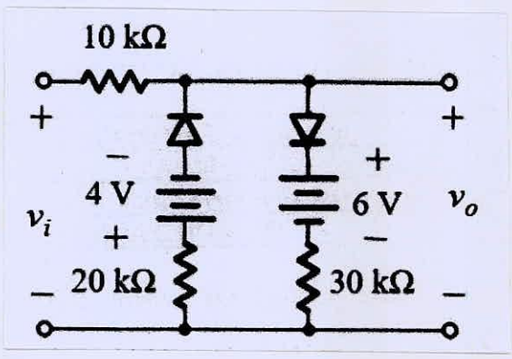

Fig. for Q. No. 8(b)

L-2/T-1/BME **Date: 05/04/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2020-2021

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** questions.

1. (a) Write down a function called *is_fib_prime(int n)* that checks whether the *n*th Fibonacci number is prime or not. Your function should call two other functions, one named *fibonacci(int n)* that returns *n*th Fibonacci number (for n > 0) and the function *is_prime(int x)* that returns 1 if x is a prime and 0 otherwise. **(20)**

   (b) What is the difference between argument and parameter of a function? **(5)**

   (c) Write a function *word_count (char s[])* that counts and returns the number of words in a string s. We assume that the words in the string are separated by white space. Recall that a whitespace is a character which could be a blank, tab or new line. **(10)**

2. (a) Write a C program to find the first repeated character in a given string. **(12)**

   Sample Input/output:

   Input a string: advertisement

   Expected output:

   The first repeated character in advertisement is: e

   (b) Copy and fill out the following table in your answer script. Assume that a and b are located at the address 300 and 500 respectively. **(12)**

Program statement	a	b	a_p	b_p
int a = 6, b = 3;	6	3	-	-
int *a_p = &a, *b_p = &b;	6	3		
a = b + *a_p;				
a_p = b_p;				
b = (*a_p)*(*b_p);				
*b_p = a/b;				
*a_p = a%b;				

   (c) Suppose you are given a two-dimensional array A[3][4]. Declare a pointer variable and using this pointer, write a C code segment to print all the values of array *A* in a row-major order. Do not use array syntax, i.e., A[i][j] and instead, use only pointer syntax to access the ith element of the array. **(11)**

Contd P/2

CSE 281

3. (a) Write down a structure **employee** capable of storing the following information about an employee of an organization: **(20)**

- Employee ID number
- Age
- Salary
- Department

There are THREE departments in the organization and their codes are:
"CSE", "EEE" AND "BME".

- Use the above structure to take input of N employees' information. N will also be input to your program.
- An employee is considered as old if his/her age is over 50. Write down a function that will take an array of **employee** and the number of employees as parameters and returns the number of old employees.
- Write down a function that will take an array of **employee**, and the number of employees as parameter and will return the index of the employee getting lowest amount of salary. Call this function from your main function and print the employee's information from the returned index.

(b) What is the size of the following union? Show your calculation. **(5)**

```
typedef union {
        int i;
        char c;
        float f;
        double d;
} allType;
```

(c) Write a complete C program that counts the number of times the character 'e' appears in the text file story.txt, and that writes the number into another binary file output.dat. Make sure to include the necessary .h files, and check that story.txt has been opened successfully. **(10)**

4. (a) What is wrong with the constructor shown in the following fragment? **(4)**

```
class sample{
    double a, b, c;
public:
    double sample();
}
```

Contd P/3

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Contd... Q. No. 4

(b) What would be printed in the following program? **(6)**

```
#include<iostream>
using namespace std;
int sub1(int &n){
n--;
return n;
}
int main(){
int m = 10;
for(int j = 0; j < 10; j++)
m – = sub1(j);
cout << m<< "\n";
return 0;
}
```

(c) What is function overloading? Give example. What is its benefit? **(6)**

(d) What is the difference between private and public access specifiers of a class? What are the default access specifiers of a class and a structure? **(6)**

(e) Write down a class *Point* that can store x and y coordinates of a point in 2D space. Write the setter and getter methods of this class. Using objects of this class, write another class *Rectangle* that can store upper left corner point and lower right corner point to define a rectangle. Also provide the setter and getter methods of this class. Add another public method area() in this class that will return the area of the rectangle defined by an instance of this class. Make sure that no data member of these two classes are accessible from outside. **(13)**

SECTION – B

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

5. (a) Consider the following program codes: **(6)**

```
int S, A;
float B;
-------------------
S = A + B;
-------------------
```

Explain the necessity of using data type auto-conversion and data type casting in the above program codes for proper execution.

Contd P/4

CSE 281

Contd... Q. No. 5

(b) Some program codes are given as follows: **(4+5)**

```
int a = 0x2a3;
float x = 12.125;
---------------------------------------
printf("%-07X %#7g", a, x);
---------------------------------------
```

Show the output to be generated by the printf() function. Also show the bit-stream to be stored inside the computer memory while storing 12.125. Demonstrate your workout.

(c) A date in the form of "dd/mm/yy" is stored inside the computer-memory using only a two-byte integer number as follows: **(10)**

Day/dd					Month/mm				Year/yy						

Day part ranges from 1 to 31 is represented by 5 bits, month part ranges from 1 to 12 is represented by 4 bits and year part by 7 bits. Write a C function that takes an integer representing a date as input and print day, month and year as the output in the given form, e.g., like 28/11/21. Consider the prototype of the function as-

```
void printDate (int x);
```

(d) Write a C program that generates a table of values for the equation **(10)**

$$y = 2e^{-0.1t} \sin 0.5t$$

where t varies between 0 to 60. Allow the lower limit and the upper limit of t to be entered as inputs. Use a macro to evaluate the formula. Make sure that the data to be shown are properly indented.

6. (a) Write down the desirable characteristics of a good program. State the purpose of using compiler / interpreter in the process of a program execution. **(6+4)**

(b) Differentiate between expression, equation and condition with examples. Prove with appropriate reasoning that the following branching statement is not appropriate. **(6+3)**

```
switch( isalnum(10*j) && abs(i-2*j) > 0) {
    ----------------------------------
}
```

(c) Convert the following using nested if-else statement- **(4+4)**

```
x = b > 8? b < 3? b<<3 : b>4? b>> 1: b: b + 5;
```

What will be the value of x if b = 7?

Contd P/5

CSE 281
Contd... Q. No. 6

(d) Consider the following equation: **(8)**

$$\text{siny} = a + b\cos\frac{n\pi x}{L} + c\sin\frac{n\pi x}{L}$$

Write down a C program to find out the value of y in the above equation. Make sure that your program responses properly in case of invalid input as well.

7. (a) Rewrite the following code-segment using for loop- **(7)**

```
sum = 0;
do{
    printf("Enter a new number:");
    scanf("%d", &x);
    if (x) sum+=x;
}while (x);
```

(b) The last digit of a number is extracted by using % operation. For example, 4563 % 10 gives a digit 3. Write a C function that takes an integer number as input parameter and returns another integer where the digit appears in reverse order. Say, if the value of input parameter is 4563, then the return value is 3654. Don't use any array in your function. **(8)**

(c) The sine of x can be calculated approximately by summing the first n terms of the infinite series **(10)**

$$\text{sinx} = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots\ldots\ldots$$

Where x is expressed in radians. (Note: π radians = 180°)

The program takes the angle (in degree) as input and print the value of sinx as output. Assume that the result will be printed up to 3 decimal points. Don't use any mathematical function in your program.

(d) Generate the following "pyramid" of digits, using nested loops. **(10)**

1
232
34543
4567654
567898765
67890109876
7890123210987
890123454321098
90123456765432109
0123456789876543210

Contd P/6

CSE 281

Contd... Q. No. 7(d)

The program will read the number of lines to be printed and display the pyramid accordingly. Don't simply write out the multidigit strings. Instead, develop a formula to generate the appropriate output for each line.

8. (a) Consider the following scanf() statement- **(5)**

```
scanf("%d  %s", &ID, name);
```

Note that an & sign has been placed before the variable "ID" but this sign has not been used before the variable "name". Explain why?

(b) Write a C function to insert an integer element into a sorted integer array. Assume that the name of the array, A, and the number of elements already inserted in the array which is represented by the identifier, N, are declared globally. The prototype of the function is as follows- **(7)**

```
void insertSorted(int x);
```

(c) A transpose matrix is a matrix, where each row *k* is converted to column *k*. **(8)**

For example, consider the matrix A as follows-

$$A = \begin{pmatrix} 7 & 1 & 9 \\ 15 & 5 & 2 \\ 11 & 6 & 8 \end{pmatrix}$$

The transpose matrix of A is given below-

$$A = \begin{pmatrix} 7 & 15 & 11 \\ 1 & 5 & 6 \\ 9 & 2 & 8 \end{pmatrix}$$

A matrix can be converted to its transpose by (i) keeping the diagonal elements unchanged and (ii) swapping the remaining elements between upper triangular matrix and lower triangular matrix.

Write down a C function to transpose a matrix using the above principle without taking any second matrix. The function prototype is as follows:

```
void transpose(int r, int c, int  list[r][c]);
```

(d) A gray scale image is represented by a 2-dimensional array as follows, where each pixel is represented by an integer value ranges from 0 to 255. **(7+8)**

Contd P/7

CSE 281

Contd... Q. No. 8(d)

234	123	215	199	202	210
123	234	216	198	200	213
231	187	221	198	231	215
221	198	231	195	213	215
234	201	213	195	215	231
245	202	214	189	241	212
234	211	220	190	221	222

An error matrix is computed by subtracting the average value of all pixels from the value of each. Write down a C function to calculate the error matrix of a gray scale image.

Also write down a C function to calculate an error frequency list, which contains frequency of each error in the error matrix.
