L-2/T-1/BME **Date: 04/04/2023**

BANGLADESH UNIVERSI TY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **BME 201** (Biomechanics)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN** questions.

1. A certain muscle is known to behave according to the three-element model (figure 1), with an effective dashpot damping coefficient of $\eta_0 = 2.5$ N s/m. When stimulated with a single twitch in an **isometric experiment**, it produces 80% maximal tension after 40 ms. While keeping the same muscle length, the muscle is then put in series with a spring having a spring constant, k_1 (not in the figure) of 200 N/m. Calculate the tension that is measured in a new isometric experiment 20 ms after a twitch. **(15)**

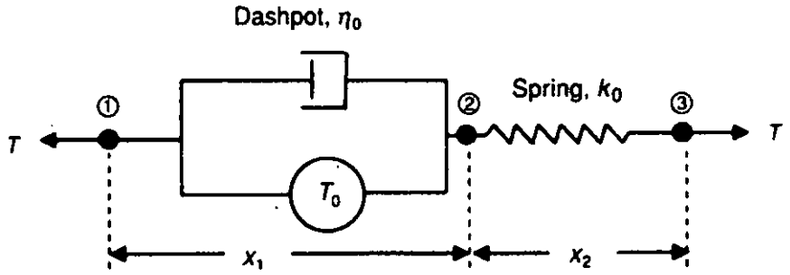

Figure for Question 1

2. (i) In a Kelvin-Voigt model, a constant stress is applied and an output like figure 2 is obtained. Derive the equation of strain response in the **creep phase only**. **(15)**

(ii) Suppose a material with E = 600 MPa is initially loaded with a stress σ_0. Half an hour after the initial loading, the strain in the material is measured to be 0.111, and after another hour, it is found to be 0.264. Calculate the time it took for the strain to reach a value of 0.001.

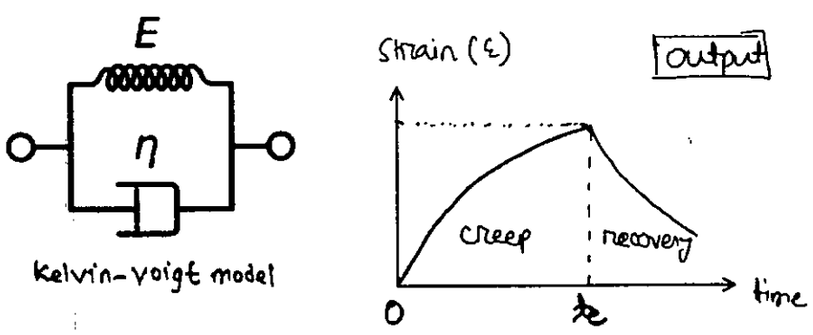

Figure for Question 2

3. (i) Which beam is used for measuring the mechanical properties of cell through atomic force microscopy? Draw a schematic of it. **(15)**

(ii) Using a schematic, explain how micropipette aspiration technique can be used for measuring the mechanical properties of RBC.

Contd P/2

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4. In figure 4, an artificial intervertebral disc (uniaxial σ_y = 8 MPa) and the stress tensor associated with its loading is shown. From an experiment it is found that, the stress tensor matrix is: **(15)**

$$\sigma = \begin{bmatrix} -2.2 & -0.57 & -0.79 \\ -0.57 & -1.1 & -0.33 \\ -0.79 & -0.33 & -0.58 \end{bmatrix}$$

(i) Using stress tensor method, find the principal stress and draw a 3D Mohr circle with the obtained values.

(ii) Determine the von Misses stress for the infinitesimal element in an artificial spinal disk. If the device safe from yielding, calculate the factor of safety.

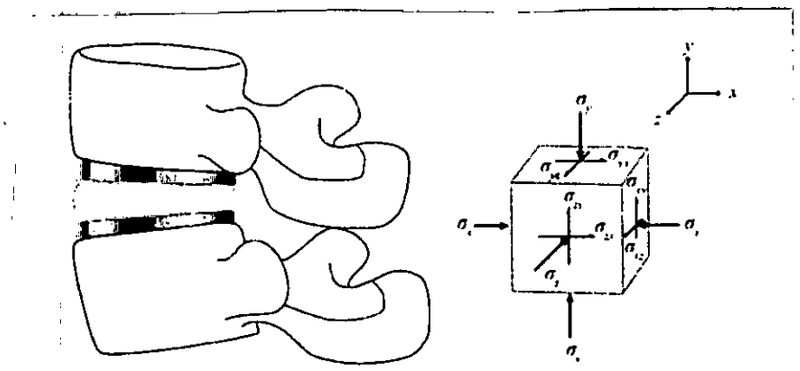

Figure for Question 4

5. Suppose a person of 1000 N weight is sitting over 1 meter length and another person of 500 N weight is standing vertically on a park bench of length 7 meter as shown figuratively in figure 5. Examine the SFD and BMD of the bench. For calculation simplicity, ignore the weight of the bench. **(15)**

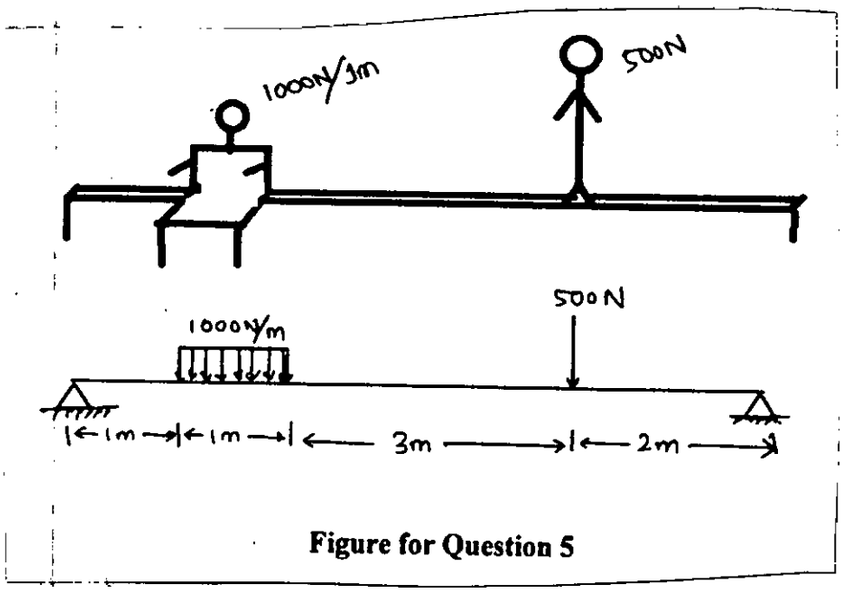

Figure for Question 5

Contd P/3

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6. (i) Explain how cartilage protects us against wear or friction.
(ii) Although Rafael Nadal is a right-hand dominant in real life, he serves and uses the left hand the most during playing tennis. Which of his hand should have more mass? Explain your reasonings.
(iii) Why our height is slightly higher in the morning and slightly lower at the night.

7. (i) In a dynamic mechanical analysis, an oscillatory stress is given as $\sigma = \sigma_0 \cos(\omega t)$ and the output is an oscillatory strain $\varepsilon = \varepsilon_0 \cos(\omega t+\delta)$. Illustrate that, in one cycle, the energy dissipated **value** is $\pi\sigma_0\varepsilon_0 \sin(\delta)$. Hint: energy dissipated value can be expressed as $\int \sigma d\varepsilon$ and time period, T can be expressed as $2\pi/\omega$. **(15)**
(ii) Express the obtained value in terms of loss modulus (G″).

8. (i) Uniaxial stress-strain curve of five different materials (numbered as 1, 2, ..., 5) is shown in the figure 8(i). Determine which of the materials have the (a) highest stiffness, (b) highest ductility, (c) highest resilience, (d) highest brittleness, and (e) highest toughness. **(15)**

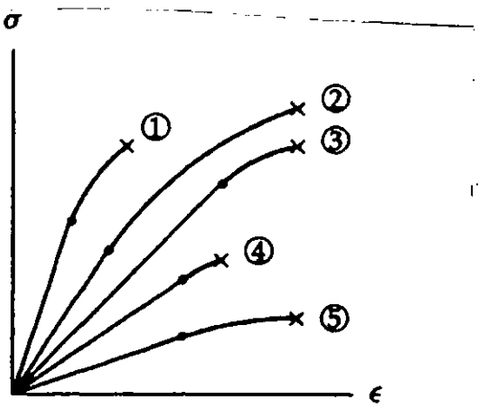

Figure for Question 8(i)

(ii) A uniform concrete slab of total weight W is to be attached, as shown in figure 8(ii), to two rods whose lower ends are on the same level. Determine the ratio of the areas of the rods so that the slab will remain level. If your need to convert into SI unit, use 1 psi (pound per square inch) = 6895 Pa.

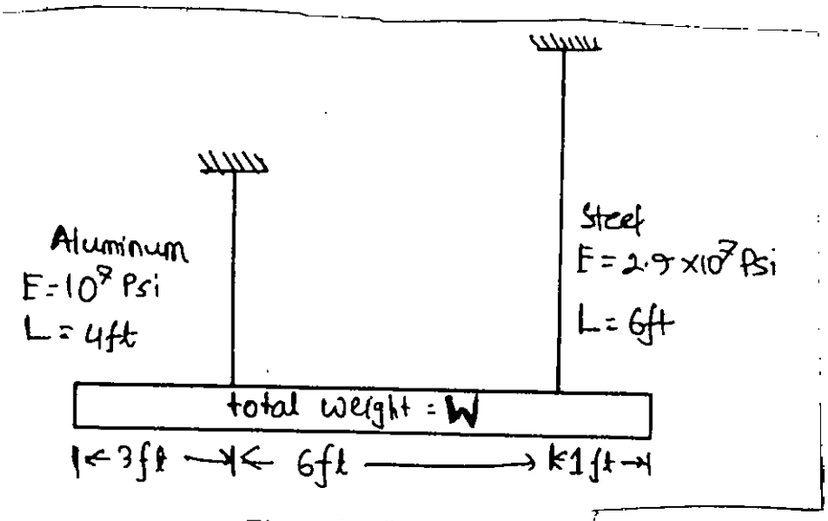

Figure for Question 8 (ii)

Contd P/4

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9. (i) Draw and explain different regions stress-strain curve of trabecular bone. **(15)**

(ii) Draw a typical force-deformation curve of a rabbit ligament and explain different regions of it.

SECTION – B

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

10. (a) Mountain climbing is a complex task requiring extensive training and dedication. While sliding down the face of a cliff, the mountaineers often prefer a technique called rappelling. As shown in Fig. 5(a), using a rope, they try to keep their body nearly horizontal and simultaneously exert force against the cliff by pushing their feet. **(15)**

Wasfia Nazreen is a famous mountaineer. Her mass is 82 kg and height is 1.90 m. Her center of gravity is 1.1 m from her feet. After winning Kilimangaro the last one of the seven summits, she was rappelling down a vertical cliff with her body raised 35° above the horizontal. She held the rope 1.40 m from he rfeet, and it makes a 25° angle with the cliff face.

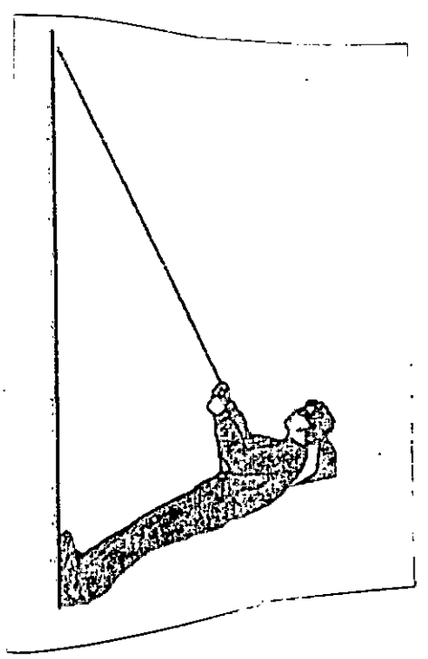

Figure for Q. 10 (*a*)

(i) What tension does her rope need to support?

(ii) Find the horizontal and vertical components of the force that the cliff face exerts on Wasfia's feet.

(iii) What minimum coefficient of static friction is needed to prevent Wasfia's feet from slipping on the cliff face if she has one foot at a time against the cliff?

Contd P/5

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Contd.... for Q. No. 10

(b) Sarvang-asana (shoulder stand pose) is a widely practiced yoga posture, as shown in Fig. 5(b). As the name suggests, this posture is helpful is exercising parts of our entire body. This asana keeps a person mentally and physically healthy and is also referred to as the 'Queen of asanas'. **(8)**

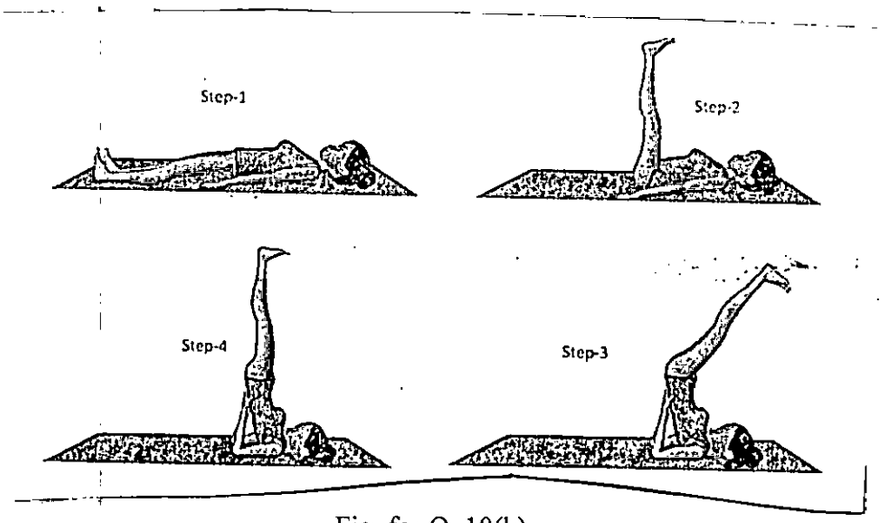

Fig. for Q. 10(b)

In the beginning, a person lies flat on his/her back, with the legs outstretched. Then, slowly, the legs are lifted until the toes are pointed straight up. To reach the final posture, it is recommended that persons with problems in their spinal column bend their legs before lifting them. Discuss the reason behind this recommendation from the perspective of biomechanics.

(c) Name the parameters required to analyze the mechanics of the body. Explain the effects of pelvic rotation and pelvic tilting while walking. **(12)**

11. (a) Robin Milord is a tall, young man with a mass of 70 kg. He is quite interested in weightlifting. Suppose one day at the gym, he is bending over to lift a heavy dumbbell from the floor, with straight legs, i.e., without bending of the knees. His silhouette is shown in the Fig. 11(a). His spinal column (shown as a rigid body) makes an angle α of 45° to the horizontal W_1 (=330 N) is the weight of his trunk which is applied at the middle of the column. The weight W_2 of the head + two (arms/forearms/hand) of 120 N added to the weight of the dumbbell of 200 N acts on the upper part of the column. The muscle force F exerted by the erector muscles acts at 2/3 of the column length that is 78 cm, forming an angle of 10° with the column. The contact force C compresses the intervertebral disc between the sacrum and the fifth lumbar vertebra. Assuming that his body is an equilibrium, draw the free-body diagram. Determine the intensities of F, C and the direction of C. **(12)**

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Contd.... for Q. No. 11

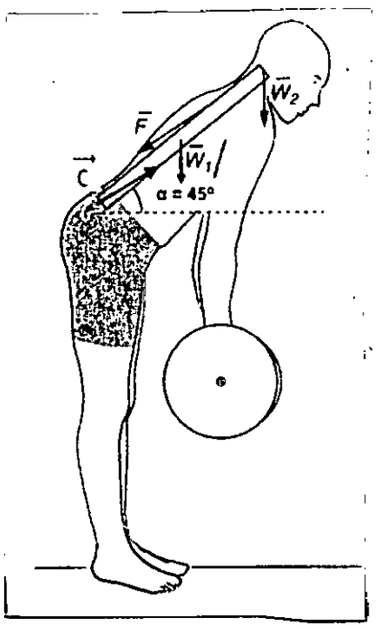
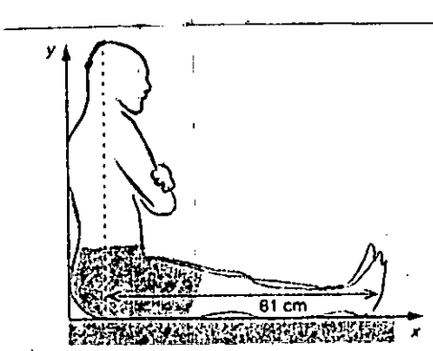


Fig. for Q. 11(a)

(b) John Olegrad is a second-year undergraduate student. He weights 70 kg and has a height of 1.70 m. Suppose, he is seated on the floor, with crossed arms and outstretched legs, as shown in the Fig. 11(b). He felt that it is not very easy to remain in this posture for a long time. The table contains the x and y coordinates of the center of gravity of some segments, as well as the respective masses. The C.G. of head and of neck-trunk-crossed arms is vertically aligned at a distance of 81 cm from the sole of his feet. Determine the location of the center of gravity of John's body and explain why he does not feed comfortable in this posture. **(12)**



Parts of body	Coordinates of C.G. x (cm)	y (cm)	Mass (kg)
Head	10.0	77.5	4.8
Neck-trunk-crossed arms	10.0	36.0	41.1
Thigh (both)	19.0	10.0	15.0
Leg (both)	60.0	10.0	6.7
Feet (both)	88.0	10.0	2.4

Fig. for Q. 11(b)

(c) NEST Biotech is Chinese company which is aiming to launch a new variant of spinner flask bioreactor dedicatedly designed for growing hepatic cells. The visualize its dynamic functionality, an experiment is being done by attaching it to a shaft as shown in Fig. 11(c). The mass of the disk is 780 gm, and it is mounted eccentrically on shaft AB. If the shaft is rotating at a constant rate 9.5 rad/s, determine the reactions at the supports when the disk is in the position shown. **(11)**

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Contd.... for Q. No. 11(c)

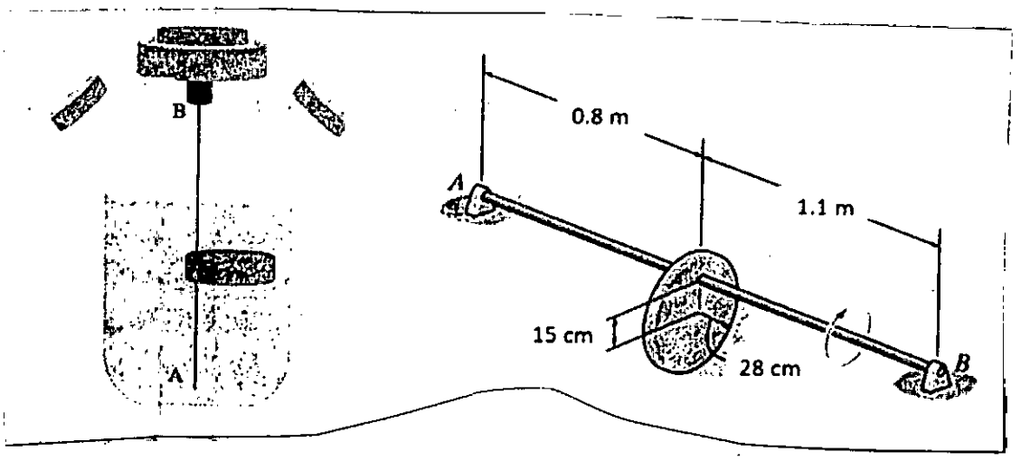

Fig. for Q. 11(c)

12. (a) Why is it important to have access ramps in the hospitals? Figure for Q. 12(a) represents situation in which simple machines based on inclined planes are employed. Determine action force and the mechanical advantage of the system. **(15)**

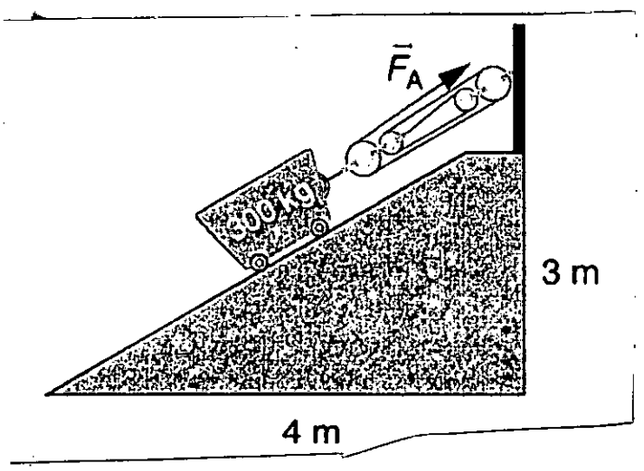

Fig. for Q. 12(a)

(b) Consider a 80 kg person preparing to dive into a pool. The diving board is represented by a uniform, horizontal beam that is hinged to the ground at point A and supported by a frictionless roller at point D. B is a point on the board directly under the center of gravity of the person. The distance between points A and B is l = 6 m and the distance between A and D is d = 2 m. If the diving board has a total weight of 1500 N, determine the reactions on the beam at points A and D. **(8)**

Contd P/8

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Contd.... for Q. No. 12(b)

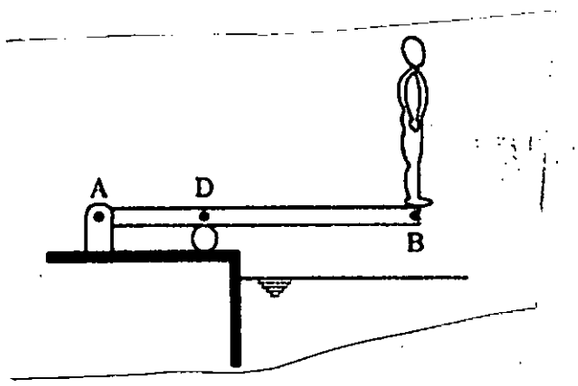

Fig. for. Q. 12(b)

(c) At Ames Research Center, NASA uses its large "20-G" centrifuge to test the effects of very large accelerations ("hypergravity") on test pilots and astronauts. In this device, an arm 8.84 m long rotates about one end in a horizontal plane, and the astronaut is strapped in at the other end. Suppose that he is aligned along the arm with his head at the outermost end. The maximum sustained acceleration to which humans are subjected in this machine is typically 12.5 g. **(12)**

(i) How fast must the astronaut's head be moving to experience this maximum acceleration?

(ii) What is the difference between the acceleration of his head and feet if the astronaut is 2.0 m tall?

(iii) How fast in rpm is the arm turning to produce the maximum sustained acceleration?

13. (a) Students of BUET BME have gone to an amusement park for refreshment and understanding the mechanics of curved path by practical example of a rollercoaster. Determine the height h of the incline D to which the 275-kg roller coaster car will reach, if it is launched at B with a speed just sufficient for it to round the top of the loop at C without leaving the track. The radius of curvature at C is 31 m. **(8)**

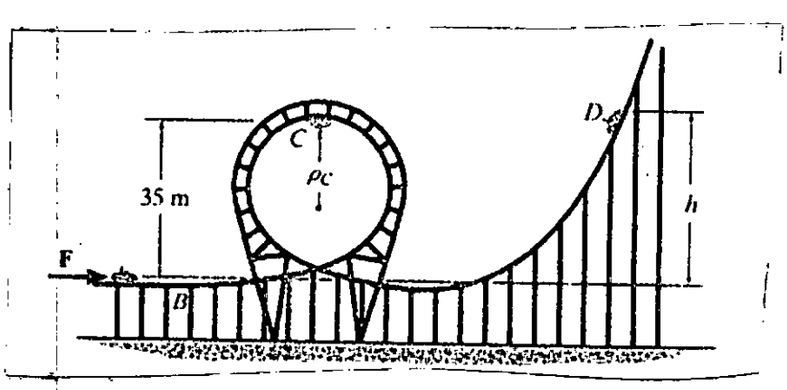

Fig. for Q. 13(a)

Contd P/9

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Contd.... for Q. No. 13

(b)The standing long jump is a well-known type of jump. In performing it, the jumper stands at a line marked on the ground with the feet slightly apart. The athlete takes off and lands using both feet, swinging the arms and bending the knees to provide forward drive. Using force plates, we can measure the impulsive forces involved, get the velocity and acceleration profiles, analyze the gait pattern etc. **(27)**

Consider the force versus time recording shown in Fig. 13(b) for an athlete making vertical jumps on a force platform. The force scale is normalized with the weight of the athlete so that the force reading is zero when the athlete is stationary (standard still or crouching). The reason for normalizing the force measurement is to be able to disregard the effect of gravitational acceleration on the impulse calculations. In this case, a positive force means a force exerted on the platform due to factors other than the weight of the person. The force versus time graph has three distinct regions. An initial "takeoff push" during which the athlete exerts a positive force on the platform, an "airborne" region during which the athlete is not in contact with the platform, and a "landing" period in which the athlete again exerts impulsive forces on the platform. These regions are approximated with rectangular areas A_1 and A_2, and a triangular area A_3. Boundaries of these regions are shown with dashed lines in Fig. 13(b).

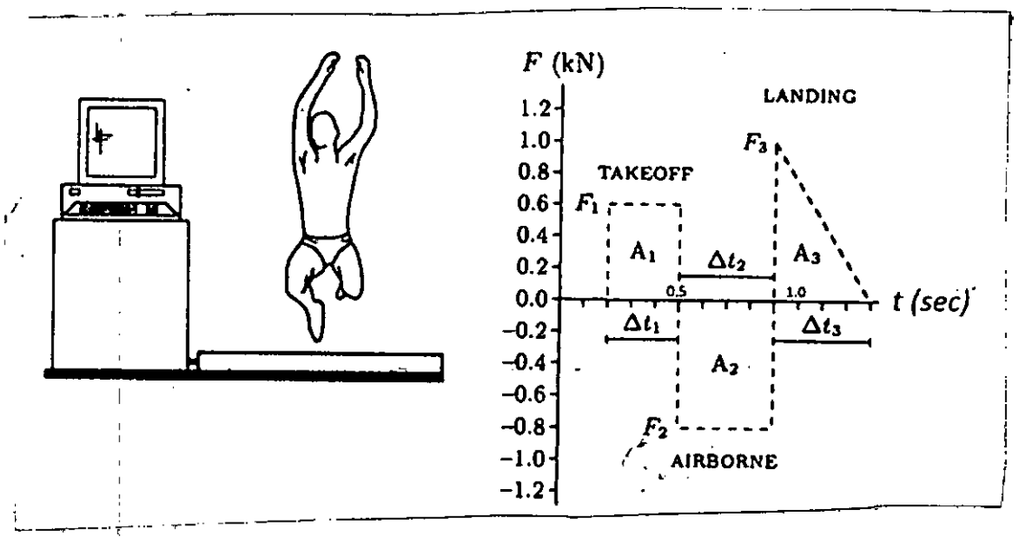

Fig. for Q. 13(b).

(i) 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.

(ii) Determine the approximate takeoff velocity of the center of gravity of the athlete, calculate the height of jump, and determine the impulse and momentum of the athlete during landing by using the approximated areas under the force versus time curve.

L-2/T-1/BME **Date: 28/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **BME 203** (Human Physiology)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN** questions.

1. With schematic, explain how does lateral inhibition make a stimulus easier to perceive? How does this help in visual perception? **(15)**

2. Differentiate between action potential and graded potential. How refractory period helps in action potential propagation? **(15)**

3. Write down the events that happen in the EC coupling phase and relaxation phase during muscle stimulation. **(15)**

4. Why hemostasis is a specific type of homeostasis. Write the steps of hemostasis and using a diagram and explain the **intrinsic** pathway of it. **(15)**

5. With necessary assumptions, equations, and calculations, show why the resting membrane potential of a nerve fiber is approximately –90 mV. **(15)**

6. (a) Calculate the "Milieu Intérieur" (in L) of a reference female whose body weight is 58 kgs. **(5)**

   (b) How does negative feedback mechanism help to maintain the automaticity of the body? **(5)**

   (c) Why positive feedback mechanism can both be helpful and destructive for our body? **(5)**

7. (a) Using a schematic, explain how do oxyntic cells create an acidic environment in the stomach? **(5)**

   (b) Draw a schematic to explain the **pantoprazole** action to reduce the HCl content of stomach. **(5)**

Contd P/2

8. (a) How does differentiation inducer (IL-3) help in building up our immune system? **(5)**

(b) With the help of schematic and graph, explain the length-tension relationship of skeletal muscle. **(10)**

9. (a) Write down the pathways of speaking written words and heard words? **(5)**

(b) Compare between spatial and temporal summations of graded potential. **(5)**

(c) Why graded potential lose its strength over time? **(5)**

SECTION – B

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

10. (a) What happens to the oxygen bound to hemoglobin during anaerobic metabolism? Fetal hemoglobin (HbF) has two gamma protein chains in place of the two beta chains found in adult hemoglobin. The presence of gamma chains enhances the ability of fetal hemoglobin to bind oxygen in the low-oxygen environment of the placenta. Draw the oxygen hemoglobin dissociation curve of HbF and compare it with a normal dissociation curve. **(15)**

(b) Why is it important to know the renal clearance of a drug? Suppose a new drug has been formulated and its effects on human body is being studied. You are asked to find the renal handling of the drug. What should your steps be to complete this task? **(15)**

(c) A person has a total blood volume of 5 L. Of this total, assume that 4 L is contained in the systemic circulation and 1 L is in the pulmonary circulation. If the person has a cardiac output of 5 L/min, how long will it take (i) for a drop of blood leaving the left ventricle to return to the left ventricle and (ii) for a drop of blood to go from the right ventricle to the left ventricle? **(5)**

11. (a) What is the resting membrane potential of cell and how is it maintained? Class III antiarrhythmic compounds block potassium channels that are responsible for phase 3 repolarization. What happens to the action potential when these channels are blocked? **(15)**

(b) What are the hormones released from the pituitary glands? State their functions. How is the secretion of antidiuretic hormone controlled by osmolarity and extracellular fluid volume? **(20)**

12. (a) 'Cardiac output is a function of both heart rate and stroke volume' — do you agree with this statement? Explain your position with appropriate reasoning. **(12)**

(b) How does glomerular filtration rate change within the body? What are the homeostatic responses to excess salt ingestion? **(18)**

(c) Describe the role of parathyroid hormone in maintaining bone density? **(5)**

Contd P/3

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13. (a) Describe the changes in intrapleural pressure and alveolar pressure during a normal breathing cycle. Compare the pressures across the alveoli and conducting airways during forced expiration in a normal person and a person with emphysema. **(15)**

(b) Four different ECG waveforms are shown in Figure for Question No. 13. Figure (a) is a normal ECG waveform with regular heartbeat. Identify the pathological conditions that may result in the rest of the ECG waveforms. Explain the reason behind your identification. **(15)**

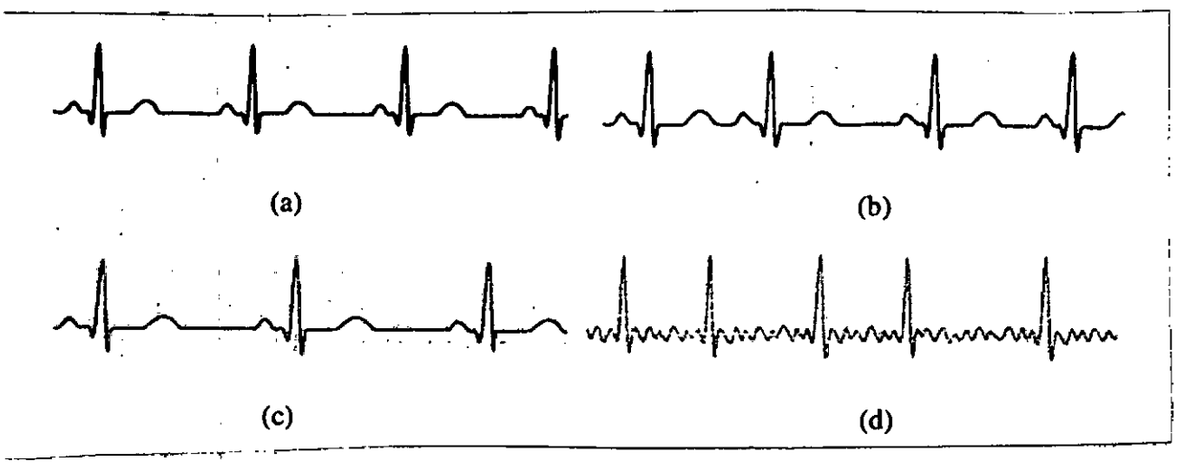

Figure for Question No. 13

(c) Explain the ventilation-perfusion defects in the case of pulmonary embolism and airway obstruction. **(5)**

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L-2/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Form the differential equation representing the family of curves $y^2 = a(b^2 - x^2)$ by eliminating the arbitrary constants 'a' and 'b'. Identify the order, degree and linearity of the differential equation. **(11)**

   (b) (i) How many arbitrary constants are there in the particular solution of a differential equation of third-order? Determine the particular solution of the differential equation **(8+5=13)**

$$\tan x \frac{dy}{dx} = 2y - 8, \quad y\left(\frac{\pi}{2}\right) = 0.$$

   (ii) Represent graphically the one parameter family of solutions of $\frac{dy}{dt} = 0.2y$.

   (c) Ten grams of the plutonium isotope 239_{Pu} were released in a nuclear accident and the half-life of 239_{Pu} is 24,100 years. How long will it take for the 10 grams to decay to 1 gram? **(11)**

2. (a) Explain integrating factor in ordinary differential equations. Check whether the differential equation is $(y^4 + 2y)dx + (xy^3 + 2y^4 - 4x)dy = 0$ exact or not. If not, then reduce it into exact form and hence solve. **(13)**

   (b) Solve the following differential equations: **(11+11=22)**

   (i) $x\,dy - y\,dx = \sqrt{x^2 + y^2}\,dx$

   (ii) $y \log y\,dx + (x - \log y)dy = 0$.

3. (a) Find the complementary function and particular integral of the following differential equation **(11)**

$$\frac{d^3y}{dx^3} - 3\frac{d^2y}{dx^2} + 4\frac{dy}{dx} - 2y = e^x + \cos x$$

   (b) Solve the following Cauchy-Euler's equation **(11)**

$$(x^2D^2 - 2xD + 2)y = x^2 \log x, \qquad D = \frac{d}{dx}$$

Contd P/2

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Contd.... for Q. No. 3

(c) The differential equation for the amplitude of vibration of the vehicle mass $y(t)$ is given by $120\frac{d^2y(t)}{dt^2}+1920\frac{dy(t)}{dt}+12000y(t)=1200\sin 10t$ **(13)**

(i) Solve the differential equation using the following initial conditions: $y(0)=0$ and $\frac{dy(t)}{dt}|_{t=0}=5m/s$.

(ii) What will be the position of the vehicle mass 2 seconds after the initiation of the vibration?

4. (a) Solve the non-linear differential equation $\frac{d^2y}{dx^2}=\sqrt{1-\left(\frac{dy}{dx}\right)^2}$. **(11)**

(b) Applying the method of variation of parameter solve the ODE $\frac{d^2y}{dx^2}+y=\sec x$. **(11)**

(c) Factorize the operator on the L.H.S of $\left[(x+2)D^2-(2x+5)D+2\right]y=(x+1)e^x$ and hence solve it. **(13)**

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 Fröbenius: **(25)**

$$2x^2\frac{d^2y}{dx^2}-x\frac{dy}{dx}+(x-5)y=0$$

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

$$\phi\left(e^x+y^2+z^2,\ x^2-3y^2+2z\right)=0$$

6. (a) Find the general integral of the partial differential equation $(y-z)p+(z-x)q=x-y$ and also the integral surface which passes through the line $z = 0, y = 2x$. **(11)**

(b) Using Charpit's method find the complete integral of the following partial differential equations:

(i) $16p^2z^2+9q^2z^2+4z^2-4=0$ **(12)**

(ii) $yzp^2-q=0$. **(12)**

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7. Solve the following higher order partial differential equations:

(a) $\left(D_x^3 - 4D_x^2 D_y + 4D_x D_y^2\right)z = \sin(2x+y)$ **(11)**

(b) $\left(D_x + D_y - 1\right)\left(D_x + 2D_y - 3\right)z = 2x + 3y$ **(12)**

(c) $\left(3D_x^2 - 2D_y^2 + D_x - 1\right)z = 4e^{x+y}\cos(x+y)$ **(12)**

8. (a) Find the general solution of the following higher order partial differential equation: **(15)**

$$\left(x^2 D_x^2 - 2xyD_x D_y - 3y^2 D_y^2 + xD_x - 3yD_y\right)z = x^2 y\cos\left(\log x^2\right)$$

(b) Solve the following wave equation by the method of separation of variables **(20)**

$$\frac{\partial^2 u}{\partial t^2} = 16\frac{\partial^2 u}{\partial x^2}$$

$$u(0,t) = 0, u(2,t) = 0, t > 0$$

$$\frac{\partial u}{\partial t} = 0 \text{ when } t = 0 \; u(x,0) = x(2-x), 0 < x < 2.$$

L-2/T-1/BME **Date: 11/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

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) For the circuit shown in Fig. for Q. No. 1(a), find the collector current I_c and collector emitter voltage V_{CE}. Assume $V_{BE} = 0.7$ V and $\beta = 50$. **(20)**

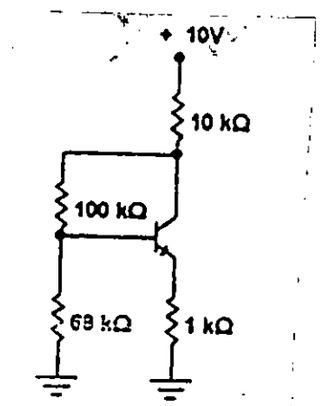


Fig. for Q. No. 1(a)

(b) For the circuit shown in Fig. for Q. No. 1(b), let $\beta = 100$ and $V_{BE} = 0.7$ V. (i) Find V_{TH} and R_{TH} for the base circuit. (ii) Determine I_{CQ} and V_{CEQ}. **(15)**

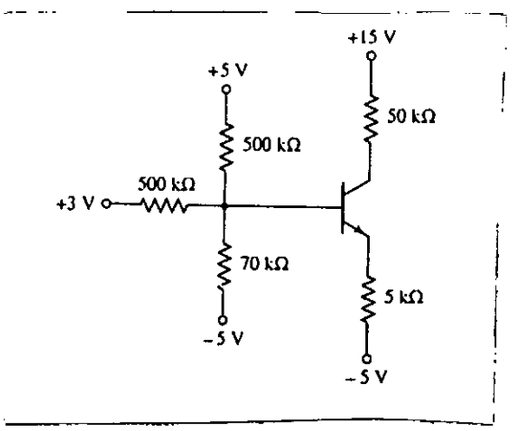


Fig. for Q. No. 1(b)

Contd P/2

EEE 273/BME

2. (a) Consider the circuit shown in Fig. for Q. No. 2(a). The transistor parameters are β = 100 and V_A = 100 V. Assume the thermal voltage is 26 mV. Determine Ri, Av = v_o/v_s, and $A_i = i_o/i_s$. **(25)**

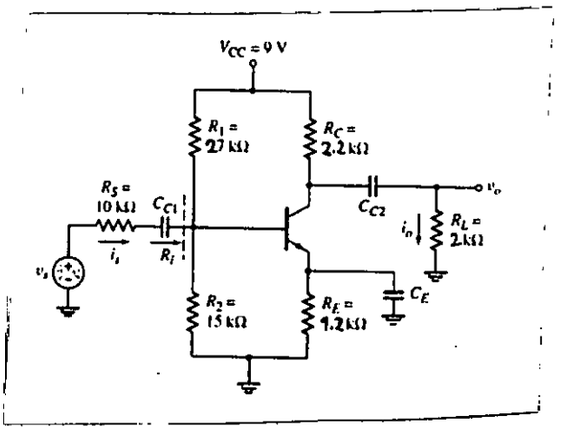


Fig. for Q. No. 2(a)

(b) Design a circuit using the ideal operational amplifiers that would implement the following equation: $10V_1 - 5\frac{dV_2}{dt} + 2\int(V_3)\,dt$. Also show the circuit diagram that implements the design. **(10)**

3. (a) The NMOS and PMOS transistors in the circuit of Fig. for Q. No. 3(a) are matched with $k_n'\left(\frac{W}{L}\right)_n = k_p'\left(\frac{W}{L}\right)_p$ = 1 mA/V^2 and $V_{tn} = -V_{tp} = 1V$. Assume λ = 0 for both devices. Find the drain currents i_{DN}, i_{DP} and the voltage v_0 for v_1 = 0 V, +2.5 V, and – 2.5 V. **(20)**

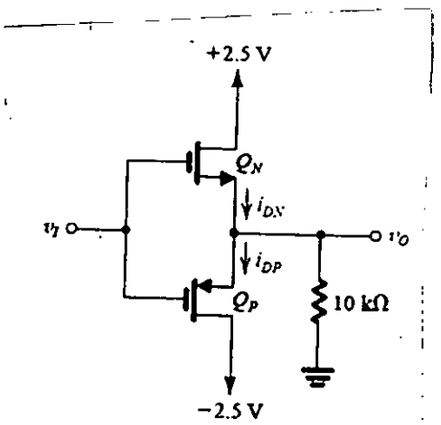


Fig. for Q. No. 3(a)

Contd P/3

EEE 273/BME

Contd.... for Q. No. 3

(b) Consider the circuit in Fig. for Q. No. 3(b). The nominal transistor parameters are V_{TN} = 0.6 V and $k_n' = 120\,\mu A/V^2$. Neglect the channel length modulation. Design the width-to-length ratio required in each transistor such that I_{DQ} = 0.8 mA, V_1 = 2.5 V, and V_2 = 6 V. **(15)**

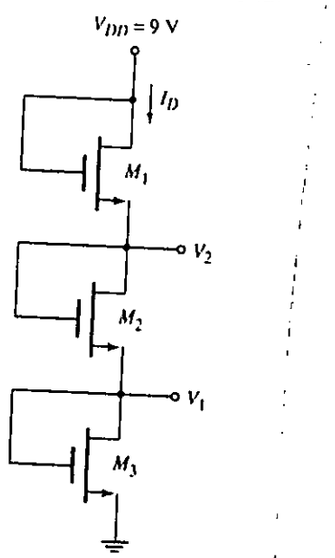


Fig. for Q. No. 3(b)

4. A source-follower circuit with a saturated load is shown in Fig. for Q. No. 4. The transistor parameters are V_{TND} = 1 V, K_{nD} = 1 mA/V^2 for M_D, and V_{TNL} = 1 V, K_{nL} = 0.1 mA/V^2 for M_L. Assume λ = 0 for both transistors. Let V_{DD} = 9 V. (a) Determine V_{GG} such that the quiescent value of v_{DSL} is 4 V. (b) Show that the small-signal open-circuit (R_L = ∞) voltage gain about this Q-point is given by $A_v = \dfrac{1}{1+\sqrt{K_{nL}/K_{nD}}}$.

(c) Calculate the small-signal voltage gain for R_L = 4 kΩ. **(35)**

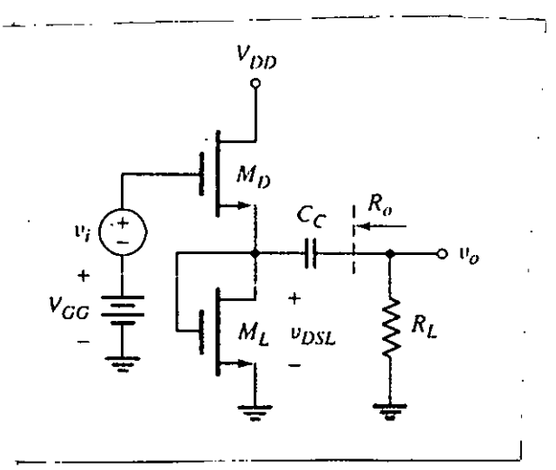


Fig. for Q. No. 4

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.
All the symbols have their usual meanings. Assume reasonable values for any missing data

5. (a) In each of the ideal diode circuits shown in Fig. for. Q. No. 5(a), v_I is a 1khz, 10-V peak sine wave. Sketch the waveform resulting at v_O. **(20)**

   (b) In the circuit shown in Fig. for Q. No. 5(b), D1 has 10 times the junction area of D2. What is the value of V? Assume room temperature. **(15)**

6. (a) Design a 7.5-V zener regulator circuit using a 7.5-V zener specified at 12 mA. The zener has an incremental resistance r_z = 30 Ω and a knee current of 0.5 mA. The regulator operates from a 10-V supply and has a 1.2-kΩ load. What is the value of R you have chosen? **(15)**

   (b) For the bridge rectifier circuit of Fig. for Q. No. 6(b), use the constant voltage-drop diode model to show that the average of the output voltage is $V_0 \approx (2/\pi)V_s - 2V_D$ and the peak diode current is $(V_s - 2V_D)/R$. If v_S is a 12-V (rms) sinusoid, $V_D \approx 0.7$ V, and R = 100 Ω, what is the average output voltage, peak diode current, and PIV. **(20)**

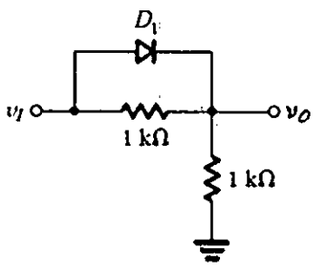
7. (a) In the circuit shown in Fig. for Q. No. 7(a), the voltage at the emitter was found to be –0.7 V. If β = 50, find I_E, I_B, I_C, and V_C. **(15)**

   (b) For the circuit shown in Fig. for Q. No. 7(b), find the voltages at all nodes and the currents through all branches. Assume β = 50. **(20)**

8 (a) Consider an amplifier circuit using a BJT having $I_S = 10^{-15}$ A, a collector resistance R_C = 6.8 kΩ, and V_{CC} = 10 V. Determine the value of V_{BE} required to operate the transistor at V_{CE} = 3.2 V. What is the corresponding value of I_C? Find the voltage gain at this bias point. If an input sine-wave of 5-mV peak amplitude is superimposed on V_{BE}, find the amplitude of the output sine-wave signal (assume linear operation). **(15)**

   (b) For the circuit shown in Fig. for Q. No. 8(b) determine the voltage gain. Assume β = 100. **(20)**

Contd..... P/5



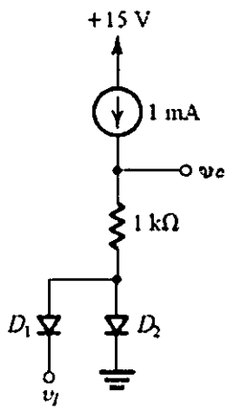


Fig. for Q. No. 5(a)

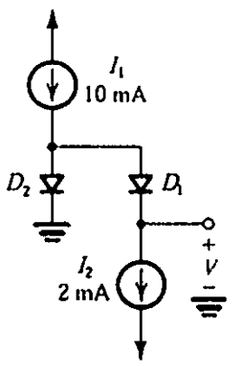


Fig. for Q. No. 5(b)

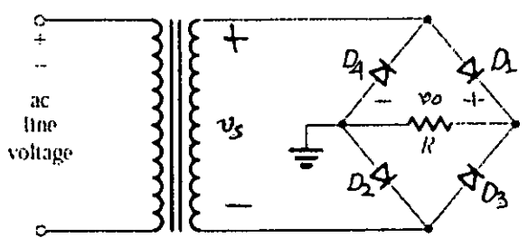


Fig. for Q. No. 6 (b)

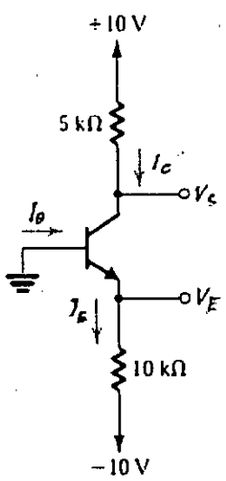


Fig. for Q. No. 7(a)

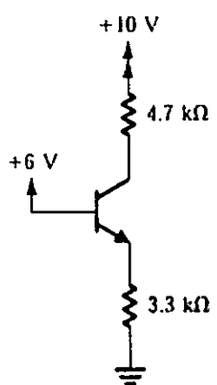


Fig. for Q. No. 7(b)

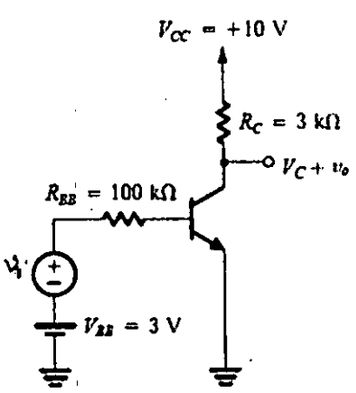


Fig. for Q. No. 8(b)

L-2/T-1/BME **Date: 06/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

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

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.

Carefully observe the instructions given in each question. Failure to follow the instructions may result in deduction of full marks. Your program should produce correct outputs for all valid inputs, not for the sample inputs only.

1. (a) Write both recursive and non-recursive functions to calculate ${}^{n}C_{r}$. For the recursive function, you can take help from the formula: **(7+8+5=20)**

$$ {}^{n}C_{r} + {}^{n}C_{r-1} = {}^{n+1}C_{r} $$

Your function should take only two parameters- an integer n and an integer r, and return the value of ${}^{n}C_{r}$.

You cannot use any static or global variable.

Describe the advantage of the recursive approach over the non-recursive approach in terms of data overflow.

(b) Outline the differences between break and continue with respect to a loop. Discuss one usage of break that doesn't involve loop. **(5+5=10)**

(c) Mr X claims that we don't need to return an array from a function if we can pass a blank array of proper shape to the function as a parameter. Prove or refute his claim. **(5)**

2. (a) We can sum the squares of the digits of a positive integer and add them, then we get another positive integer. We can do the same on the new positive integer. It can be shown that if we perform this operation repeatedly, we will always come to either 1 or 4. This process generates a sequence of integers, and we are interested in the length of that sequence. For example, in case of 44 and 85, the sequences are as follows: **(20)**

$$44 \rightarrow 32 \rightarrow 13 \rightarrow 10 \rightarrow 1$$

$$(4^2 + 4^2 = 32, 3^2 + 2^2 = 13, 1^2 + 3^2 = 10, 1^2 + 0^2 = 1)$$

$$85 \rightarrow 89 \rightarrow 145 \rightarrow 42 \rightarrow 20 \rightarrow 4$$

$$(8^2 + 5^2 = 89, 8^2 + 9^2 = 145, 1^2 + 4^2 + 5^2 = 42, 4^2 + 2^2 = 20, 2^2 + 0^2 = 4)$$

Sequence length for 44 is 5 and sequence length for 85 is 6.

Write a C program that takes an integer $n\,(n \geq 1)$ as input and prints the largest sequence length for all integers from 1 to n (inclusive). Also print the integer from which the largest sequence was generated. In case of multiple sequences having the same length, you can consider any one of them.

Contd P/2

CSE 281

Contd.... for Q. No. 2

(b) Write a C Program to print all the non-repeated elements located within the two diagonals of an input integer matrix. Take the number of rows and columns of the matrix as input, take the elements of the matrix as input, then print the output. **(15)**

For example, consider the following matrix.

```
1 2 1 5
3 3 4 6
5 7 7 9
3 6 8 0
```

The elements of the main diagonal are 1, 3, 7, 0. But 1, 3 and 7 are also present elsewhere in the matrix (notice that 7 is present in the antidiagonal). So the only non-repeated element in the main diagonal is 0.

Similarly, the elements of the antidiagonal are 5, 4, 7, 3. But 5, 7 and 3 are present elsewhere in the matrix. So the only non-repeated element in the antidiagonal is 4.

For this example, you have to print

```
0 4
```

Keep in mind that a diagonal may have no non-repeated element or multiple non-repeated elements. If both diagonals of a matrix has no non-repeated element, the matrix has no non-repeated element located within the two diagonals. In that case , print "no non-repeated element".

3. (a) Here are some dates and the corresponding weekdays. **(15)**

Date	Weekday
1 January 2000	Saturday
1 January 2001	Monday
1 January 2002	Tuesday
1 January 2003	Wednesday
1 January 2004	Thursday
1 January 2005	Saturday
1 January 2006	Sunday
3 March 2004	Wednesday
3 March 2005	Thursday

If you look at the pattern closely, you will see that if a 29 February doesn't pass in between, the same date of the following year has the next weekday, i.e. one day ahead of the previous year. On the other hand, if a 29 February passes in between, the same date of the following year has a weekday two days ahead of the previous year.

Contd P/3

CSE 281

Contd.... for Q. No. 3(a)

This fact can also be explained mathematically as

365 % 7 = 1

366 % 7 = 2

Using the idea mentioned above, write a C program to calculate the weekday of any date after 1 January 2000. As you know from the table, 1 January 2000 was a Saturday. Take the day, month and year as integer inputs from the user and print the weekday. **You cannot use any loop, function or recursion.**

(b) Given an array of integers as input, write a C program to print all the peak elements of the array. A peak element is an element that is not smaller than its neighbors. For corner elements, we need to consider only one neighbor. **(15)**

For example, {5, 10, 20, 15} has only one peak element: 20. The element 20 has neighbors 10 and 15, both of them are less than 20.

{12, 20, 19, 2, 23, 67, 90} has two peak elements: 20 and 90. The element 20 has neighbors 12 and 19, both of them are less than 20. Similarily, 90 has only one neighbor 67 which is less than 90.

If all elements of the input array are the same, every element is a peak element.

Take the number of elements of the array as input first, then take the elements of the array as input. Finally print all the peak elements of the array.

Sample Input	Corresponding Output
4 3 23 56 87	87
5 90 80 70 43 12	90
6 89 32 56 56 9 12	89 56 56 12
4 8 8 8 8	8 8 8 8

(c) Briefly explain the importance of stack in function calls. **(5)**

4. (a) Given a string as input, write a C program to print the words of the string in reverse order. The words in the input string are separated by one or more spaces. In case of output, you can keep just one space between words. You can assume that the input string doesn't contain more than 100 words, and each word doesn't contain more than 20 characters. The input string can have at most 3000 characters. You can assume that there are not leading or trailing spaces in the input string. **(15)**

Sample Input	Corresponding Output
The quick brown fox	Fox brown quick The
please call 999	999 call please
Send an email to r_6@gmail.com	R_6@gmail.com to email an send

Contd P/4

CSE 281

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

(b) While passing an int array to a function, we need to pass the length of the array as an additional parameter to the function. Explain the reason behind it. Also explain why we don't need to do the same in case of a string. **(5+5=10)**

(c) Write and explain the output of the following C program. **(10)**

```
#include <stdio.h>

double t=9.8;

void f(int a)
{
    a=3;
    t=4.7;
}

int main()
{
    int a=17;
    float b=18/4*5-6;
    int c=b;
    int flag=1;
    printf("%x %f %d\n",a,b,c);
    if(a>=17 && b<15 || c>0){
        flag=0;
    }
    if(flag=1){
        printf("%d\n",flag);
    }
    f(a);
    printf("%d %d\n",a,(int)t);
    return 0;
}
```

SECTION – B

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

5. (a) Write down a structure **Student** capable of storing the following information about a student. **(20)**

- Name (maximum 20 letters)
- Student ID
- CGPA

Write down another structure **Department** capable of storing the following information about a department in BUET.

- Name (maximum ten letters)
- Array of students (maximum 120 students per department)

Contd P/5

CSE 281

Contd.... for Q. No. 5(a)

Write down a C code that does the following:

- Take the name of the department as input.
- Take the number of students in that department as input.
- For each student, input their name, student id, and CGPA.
- Store the information of the department and students using structures.
- Store all students inside the department as an array.

(b) **Using pointer arithmetic** write a C program that will replace any special character of a string with an underscore (_). A special character is any character except A-Z, a-z, and 0-9. **(15)**

Sample Input	Corresponding Output
Hello%World##	Hello_World__
Prog_am%ing1234$	Prog_am_ing123_

You cannot use [ ] for indexing. You cannot use any additional array. You cannot use any library function except the library function used for input/output purposes (printf, scanf, puts, gets, etc.)

6. (a) Write a complete C program that counts the number of times the letter "h" appears in a file "story.txt" and prints the number. Make sure to include the necessary header files and check that story.txt has been opened successfully. **(10)**

(b) Write a C function **int evenParity(int x)** that takes an integer x as a parameter and returns 1 if there is an even number of 1's in the binary representation of x, and returns 0 otherwise. **(10)**

(c) Write a c function **int toggleRange(int x, int start, int end)** that takes an integer x, a start position, and an end position as parameters. This function will toggle every bit within the range of start to end in the binary representation of x, keeping other bits unchanged. **(15)**

For example, take a sample function called **toggleRange(109, 3, 5)**.

Bit No.	6	5	4	3	2	1	0
Binary	1	1	0	1	1	0	1
result	1	0	1	0	1	0	1

The equivalent binary format of 109 is 1101101, and the range is 3 to 5. So, the output should be 1010101, which is 85 in decimal. For this example, your function should return 85.

Contd P/6

CSE 281

7. (a) Consider the following C code. The code compiles but fails to execute. Explain the reason behind this. How can we resolve the problem? **(10)**

```
#include <stdio.h>
#include <string.h>

int main()
{
    char *a;
    char b[] = "hello";
    strcpy(a, b);
    puts(b);
}
```

(b) Write and explain the outputs of the following C++ code. **(10)**

```
#include <cstdio>

int func1(int a, int b) {
    int temp;
    temp = a;
    a = b;
    b = temp;
}

int func2(int& a, int& b) {
    int temp;
    temp = a;
    a = b;
    b = temp;
}
```

```
int main() {
    int a = 1, b = 2;
    func1(a, b);
    printf("%d %d\n", a, b);
    func2(a, b);
    printf("%d %d\n", a, b);
}
```

CSE 281

Contd.... for Q. No. 7

(c) Write down a class **Complex** that can store the real (x) and imaginary part (y) of a complex number. The real and imaginary members must be private. Write an appropriate constructor for this class. Also, write the public getter and setter functions of this class. Add a public function absolute() in this class that will return the absolute value $\left(\sqrt{x^2+y^2}\right)$ of the complex number. Use operator overloading to add and multiply two complex numbers. **(15)**

8. (a) Write and explain the output of the following C++ code. **(5)**

```
#include <iostream>
using namespace std;

int func(int x) {
    return x - 10;
}
double func(double x) {
    return x - 5;
}

int main() {
    cout << func(20) << endl;
    cout << func(20.0) << endl;
}
```

(b) What needs to be fixed with the constructor shown in the following C++ code? **(5)**

```
class point {
    float x, y;
public:
    float point();
};
```

(c) Briefly describe the features of object-oriented programming. **(10)**

Contd P/8

CSE 281

Contd.... for Q. No. 8

(d) Consider the following C++ code snippet. **(15)**

```
#include <iostream>

class A {
private:
    int a1;
protected:
    int a2;
public:
    int a3;
};
```

```
class B: protected A {
private:
    int b1;
protected:
    int b2;
public:
    int b3;
};

class C: public B {
};
```

Which of the following members can be accessed by class C – a1, a2, a3, b1, b2, b3? Also, mention their proper access specifier with respect to class C.
