KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
EEE 2131
(Electronics)

Time: 3 Hours | Total Marks: 210

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

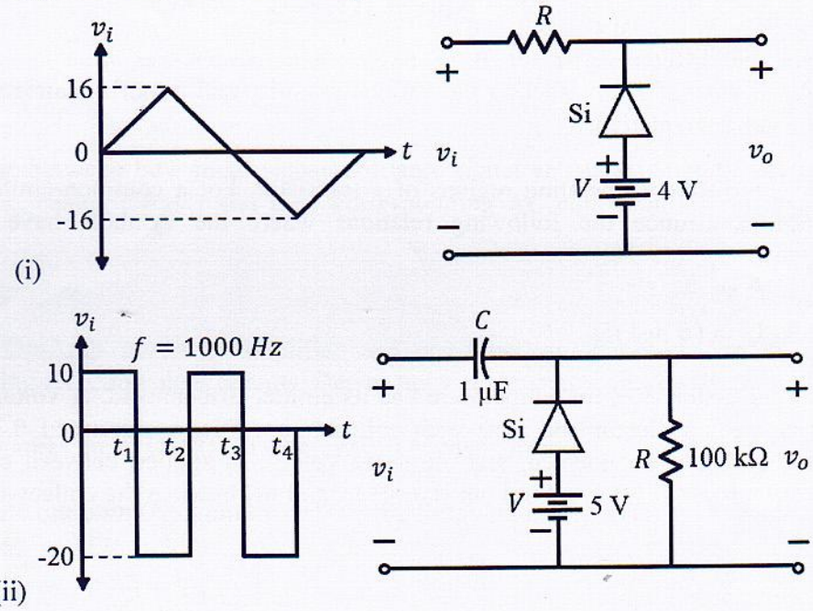
SECTION-A

1(a) Briefly describe the formation of a PN junction with proper illustration. 08

1(b) Define breakdown voltage and knee voltage. From Shockley's equation, draw the V-I characteristic curve of a semiconductor diode and identify breakdown and knee voltages. 08

1(c) Differentiate various types of resistance levels of a diode in a tabular format specifying their equations, special characteristics, and graphical determinations. 09

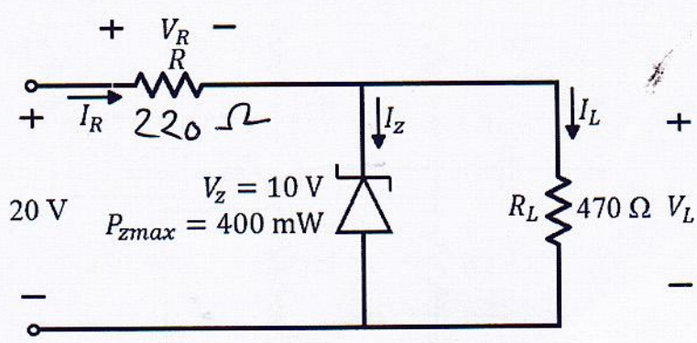
1(d) Determine v_0 (waveform) of the following networks. Consider Si diode with $V_k = 0.7\ V$. 10



2(a) "The efficiency of a full-wave rectifier is double than that of a half-wave rectifier." – Justiy this statement. 13

2(b) Define and derive the expression of ripple factor. Also show that the ripple factor of half-wave and full-wave rectifier are 1.21 and 0.48, respectively. 10

2(c) For the network shown below, determine V_L, V_R, I_L, I_R, I_z, and P_z. 12



3(a) Derive the electron and hole concentration equations using necessary diagrams and then deduce the mass action law. 14

3(b) Explain the drift and diffusion of charge carriers in a semiconductor with necessary diagram. 10

3(c) Given that, atomic concentration in silicon is 5 x 10^{22} cm^{-3}, intrinsic concentration, n_i = 1.0 x 10^{10} cm^{-3}, drift mobility of electron, μ_e = 1350 $cm^2V^{-1}s^{-1}$, and drift mobility of hole, μ_h = 450 $cm^2V^{-1}s^{-1}$. Find the resistance of 1 cm^3 pure silicon crystal. Also find the resistance when the crystal is doped with arsenic; the amount of doping is 1 in 10^9. 11

4(a) What is a multivibrator? Explain the operation of a multivibrator and show that it generates square waves as output. 10

4(b) What is an oscillator? How does it differ from alternator? 05

4(c) Describe the principle of operation of a Tuned Collector Oscillator with neat sketch. 10

4(d) Determine the operating frequency and feedback fraction for a Colpitt's oscillator; where, C_1 = 0.001 μF, C_2 = 0.01 μF, and L = 15 μH. 10

SECTION-B

5(a) What are the different types of BJT? Sketch and explain the basic construction and operation of each of them labeling the various majority and minority carriers. Also write down the current equations. 12

5(b) Mention the different operating regions of a transistor. For a common-emitter transistor configuration, deduce the following relations where the symbols have their usual meanings. 11

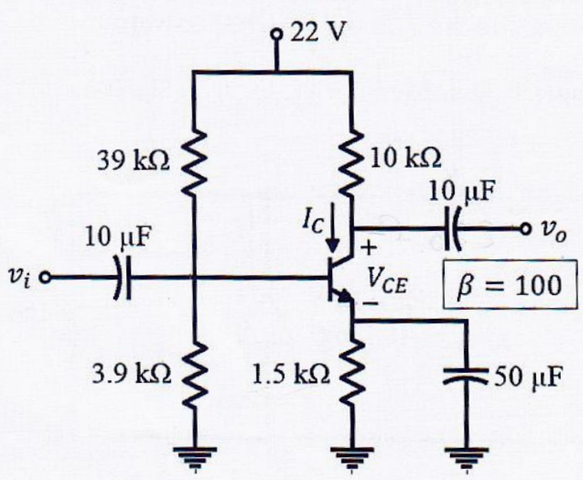
i) $\beta = \frac{\alpha}{1-\alpha}$

ii) $I_E = (\beta + 1)I_B$

5(c) An n-p-n transistor at room temperature has its emitter disconnectd. A voltage of 5 V is applied between collector and base with collector positive, a current of 0.2 μA flows. When the base is disconnected, and the same voltage is applied between collector and emitter, the current is 20 μA. Find out i) α, ii) I_E, and iii) I_B when the collector current is 1 mA. 12

6(a) Define stabilization and stability factor. Show that, $S = \frac{\beta+1}{1-\beta(\frac{\partial I_B}{\partial I_C})}$; where the symbols have their usual meanings. 10

6(b) Determine the dc bias voltage V_{CE} and the current I_C for the transistor amplifier circuit shown below. 10



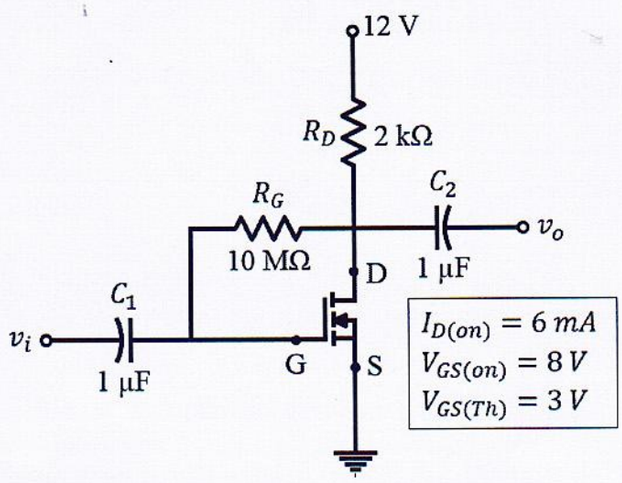
6(c) Mention the differences between BJT and FET. 05

6(d) "A JFET can be used as a constant current source." – Explain the statement with necessary diagrams. 10

7(a) "A D-MOSFET transfer characteristic follows the Shockley's equation but an E-MOSFET does not." – Justify the statement. 11

7(b) "An E-MOSFET can be used as a switch." – Justify this statement. 05

7(c) Determine I_{DQ} and V_{DSQ} for the enhancement type MOSFET shown below. 11



7(d) Differentiate between BJT small signal and large signal ac analysis. Draw different types of transistor biasing circuits and their corresponding AC equivalent circuit using the r_e model. 08

8(a) Draw the Op-Amp inverting amplifier and non-inverting amplifier circuits and their corresponding AC equivalent circuits. Derive the equations of voltage gain for both. 10

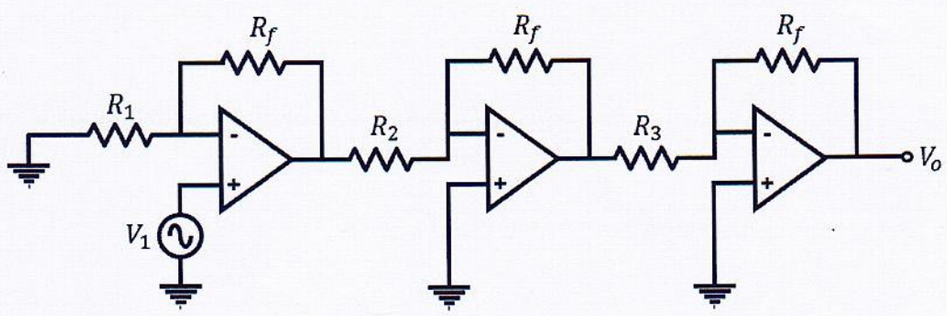
8(b) Write short notes on: i) CMRR, ii) SR, and iii) Virtual Ground. 06

8(c) Design a network with Op-Amp to perform the following operations: 10

i) $V_0 = -5V_1 + 3V_2$

ii) $V_0 = -8\frac{dV_1}{dt} + 5\int V_2 dt$

8(d) Calculate the output voltage of the Op-Amp circuit; where, R_F = 400 kΩ, R_1 = 4 kΩ, R_2 = 33 kΩ, and R_3 = 33 kΩ. For an input of V_1 = 80μV. 09



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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Hum 2131
(Engineering Economics and Accounting)

Time: 3 Hours | Total Marks: 210

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

SECTION-A

1 The following equations are for the demand and supply of a good x: 35

$$Q_d = 1800 - 2P_x \text{ and } Q_s = 300 + 3P_x$$

i) Define law of demand.
ii) How do income of the consumer, price of related goods, and taste affect the demand?
iii) Calculate equilibrium price (P) and quantity (Q).
iv) Also calculate new equilibrium price and quantity, when the slope of demand equation is 5.
v) What is the equilibrium price and quantity if per unit tax, t = Tk 4.00?

2(a) Show the differences between elastic and inelastic demands. 05

2(b) The 'Meghna corporation' is a producer of cement. The corporation wanted to determine the demand for its product. The economist informed that the demand for its cement is given by the following equation: 25

$$Q_x = 12000 - 5000P_x + 5I + 500P_c$$

Where, P_x is the price charged for Meghna cement, I is the income per capita, and P_c is the price of cement from competiting producer.
Assume, the initial values of P_x, I and P_c are \$6, \$10,000 and \$6.5, respectively.

Using the above information, determine:

i) What effect a price increase would have on total revenue (TR)?
ii) How sale of the cement would change during a period of rising income?
iii) Assess the probable impact it competing producers would raise their price.

2(c) Mention the differences between short-run and long-run production function. 05

3(a) What is market? Distinguish between monopoly and perfect competition. 10

3(b) Explain the following situation under perfect competition in the short run with conditions: 25

i) Super normal profit
ii) Lose but not shut down
iii) Shut down position

4(a) What are the types of inflation? Explain the main causes of inflation. 20

4(b) Define national income. What are the methods of calculating national income? 08

4(c) Explain income method of national income accounting. 07

SECTION-B

5(a) 'Accounting ensures accountability.' – Explain. 6

5(b) Sonya Jared opened a law office on July 1, 2022. On July 31, the balance sheet showed Cash $5000, Accounts Receivable 1,500, Supplies 500, Equipment 6,000, Accounts Payable 4,200 and Owner's Capital 8,800. During August, the following transactions occurred. 28

1. Collected $1,200 of accounts receivable.
2. Paid $2,800 cash on accounts payable.
3. Recognized revenue of $7,500 of which 4,000 is collected in cash and balance is due in September.
4. Paid salaries $2,800.
5. Withdrew $700 in cash for personal use.
6. Took a loan of $5,000 from Standart Federal Bank
7. Incurred utility expenses for month on account $270.

Required:

(i) Show Journal entries of the above transactions of August.
(ii) Prepare a tabular analysis of the August transactions beginning with July 31 balances.

6(a) What is the main purpose for preparing a trial balance? 10

6(b) From the following ledger balances of MTE Enterprise, prepare a Trial Balance as on 31 December, 2022: 20

Capital	2,50,000	Sales	54,000
Apprenticeship Premium	28,270	Discount Allowed	4,610
Deferred Advertisement	27,150	Insurance Premium	18,500
Inventory (1-1-22)	30,000	Drawings	15,000
Inventory (31-12-22)	35,000	Creditors	24,000
Cash in hand (1-1-22)	27,000	Goodwill	40,000
Return Outward	2,530	Cash in Hand (31-12-22)	15,000
Bills Payable	11,200	Equipment	30,000
Interest accrued on Investment	2,740	10% Mortage Loan	30,000
Savings Certificate	2,00,000	Copyright	17,000

6(c) Who are the users of accounting information? 05

7 The accountant of Habib & Sons has prepared the following Trial Balance: 35

Habib & Sons
Trial Balance
31 December 2022

Name of Accounts	Debit Tk.	Credit Tk.
Purchase and Sales	1,47,000	2,90,000
Goods Return	4,000	3,000
Salaries	20,000	
Insurance Premium	8,300	
Cash at Bank	15,000	
Capital		5,00,000
Debtors & Creditors	7,000	10,000
Machinery	2,80,000	
Land	4,73,200	
10% Mortgage Loan		1,00,000
Accumulated Depreciation		56,000
Provision for bad debt		500
Stock (1-1-2022)	3,000	
Adjustments:	9,59,500	9,59,500

1. Closing stock 4,000 taka.
2. Depreciate 10% on Machinery.
3. Salaries are due 6,000 taka.
4. Prepaid Insurance Premium is 2,500 taka.
5. Charge provision for bad debt @ 10%.
6. Interest on the loan is due.

Requirements: Prepare –

i) Statement of Comprehensive Income
ii) Statement of Changes in Equity
iii) Statement of Financial Position

8(a) What is conceptual framework of accounting? 05

8(b) From the following information of "Square Fashions Limited" as on 31 December 2022, you are required to determine Cost of Goods Sold and Net Income: 20

Particulars	**BDT**
Raw Materials (1-1-22)	6,400
Raw Materials (31-12-22)	7,600
Work-in-process (1-1-22)	12,300
Work-in-process (31-12-22)	15,000
Finished Goods (1-1-22)	12,500
Finished Goods (31-12-22)	9,700
Purchase of Raw Materials	54,300
Factory Cost	8,600
Depreciation	4,400
Repair of Factory Building	12,200
Office Expenses	12,500
Selling Expenses	13,200
Sales	2,50,000
Wages	44,300

8(c) Write short note on the following topics: (any five) 10

i) Historical Cost Principle
ii) GAAP
iii) Intangible Assets
iv) Prime Cost
v) Suspense Account
vi) Journal

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Math 2131
(Fourier Analysis and Laplace Transform)

Time: 3 Hours | Total Marks: 210

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

SECTION-A

1(a) Define integral transform and hence find the Kernel of the transform. Also find the Kernel of Fourier sine transform. 10

1(b) Define z-transform. Find the z-transform of $f(n)$ where, $f(n) = \begin{cases} 5^n ; & n < 0 \\ 3^n ; & n \geq 0 \end{cases}$ 10

1(c) Define causal and non-causal system with example. Check whether the following systems are causal or not. 15
i) $y(n) = x(n) - x(n-1)$
ii) $y(t) = x(t^2)$
iii) $y(t) = x^2(t)$

2(a) By applying the time shifting property, determine the signal of $x(z) = \frac{z^{-1}}{1-3z^{-1}}$ 11

2(b) State convolution theorem. Find the inverse z-transform of $x(z) = \frac{1}{1-\frac{1}{6}z^{-1}-\frac{1}{3}z^{-2}}$ by using convolution method. 12

2(c) Find the inverse z-transform of $x(z) = \frac{z}{(z-1)(z-2)(z-3)}$ using partial fraction method for ROC $3 > |z| > 2$ 12

3(a) Find the inverse Laplace transform of $\frac{s}{(s^2+1)^2}$ using convolution theorem. 08

3(b) Solve the partial differential equation $\frac{\partial U}{\partial t} = \frac{\partial^2 U}{\partial x^2}$, $U(x,0) = 3\sin 2\pi x$, $U(0,t) = 0$, $U(1,t) = 0$ where $0 < x < 1$, $t > 0$ using Laplace transform. 15

3(c) Solve the difference equation $y(n+2) + 3y(n+1) + 2y(n) = 0$ given that, $y(0) = 1$, $y(t) = 2$ using z-transform. 12

4(a) Find the Laplace transform of 12
i) $te^{-t}\sin 2t$
ii) $\frac{e^{-t}\sin t}{t}$

4(b) Using second shifting property find the Laplace transform of $g(t) = \begin{cases} (t-4)^3 ; & t > 4 \\ 0 ; & t < 4 \end{cases}$ 08

4(c) Solve the differential equation $y''(t) + y(t) = 8\cos t$, given that, $Y(0) = 1$, $Y'(0) = -1$ using Laplace transform. 15

SECTION-B

5(a) Define periodic and aperiodic signals. Check whether each of the following signals is periodic or not. If a signal is periodic, find its fundamental period. 10

i) $x_1(t) = 2\cos(10t + 1) - \sin(4t - 1)$

ii) $x_2(t) = \sin^2 t + \cos t$

5(b) If $f(x + 2\pi) = f(x)$, find the Fourier series expansion of $f(x) = \begin{cases} 0; & -\pi \le x \le 0 \\ x; & 0 < x \le \pi \end{cases}$ 15

Hence prove that $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots\cdots\cdots = \frac{\pi}{4}$

5(c) Expand $f(x) = x^2$, $0 < x < 1$, in half range Fourier sine series. 10

6(a) Write down Perseval's formula for Fourier series. If $f(x) = \begin{cases} \pi x & ; 0 < x < 1 \\ \pi(2 - x); & 1 < x < 2 \end{cases}$, 15

using half range cosine series, show that $\frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \cdots\cdots\cdots = \frac{\pi^4}{96}$

6(b) Use finite Fourier transform to solve $\frac{\partial U}{\partial x} = \frac{\partial^2 U}{\partial t^2}$, given that, $U(0,t) = 0$, $U(4,t) = 0$, $U(x,0) = 2x$ where $0 < x < 4$, $t > 0$ 12

6(c) Write down some important properties of Fourier series. 08

7(a) Write down the Dirichlets condition for Fourier series for $f(x) = \cos \alpha x$, $-\pi < x < \pi$, $\alpha \neq 0, \pm 1, \pm 3 \cdots\cdots$ and hence prove that, $\sin x = x\left(1 - \frac{x^2}{\pi^2}\right)\left(1 - \frac{x^2}{4\pi^2}\right)\cdots\cdots\cdots$ 22

7(b) Find the Fourier cosine transform of $f(x) = \frac{1}{1+x^2}$ hence derive Fourier sine transform of $\varphi(x) = \frac{x}{1+x^2}$ 13

8(a) State Fourier integral theorem. Find the Fourier sine integral of $f(x) = e^{-\beta x}$. Hence show that $\frac{\pi}{2} e^{-\beta x} = \int_0^\infty \frac{\lambda \sin \lambda x}{\beta^2 + \lambda^2} d\lambda$ 11

8(b) By using Fourier integral formula, show that $e^{-x} \cos x = \frac{2}{\pi} \int_0^\infty \frac{u^2+2}{u^4+4} \cos ux \; du$ 11

8(c) Find the Fourier sine transform of $f(x) = e^{-|x|}$ and hence evaluate $\int_0^\infty \frac{x \sin mx}{1+x^2} dx$ 13

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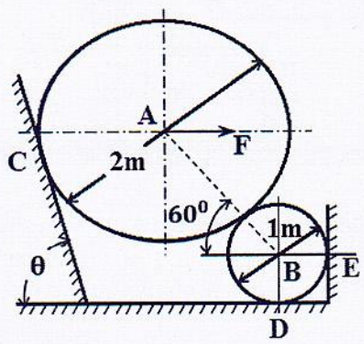
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
ME 2131
(Engineering Mechanics)

Time: 3 Hours | Total Marks: 210

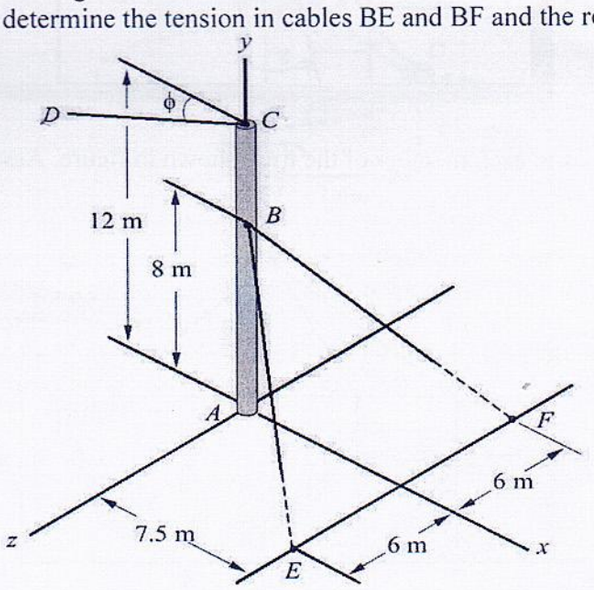
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

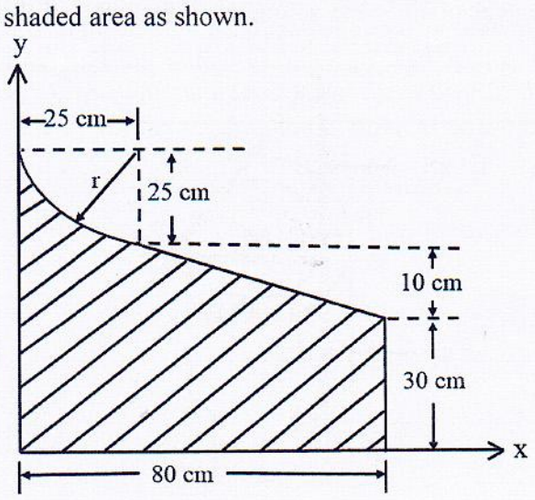
1(a) Two spheres are at rest against smooth surfaces, as shown in figure. Sphere A weighs 1400 kg and sphere B weighs 200 kg. Let F = 3500 N and $\theta = 75^0$. Find the reactions at C, D, E. 18



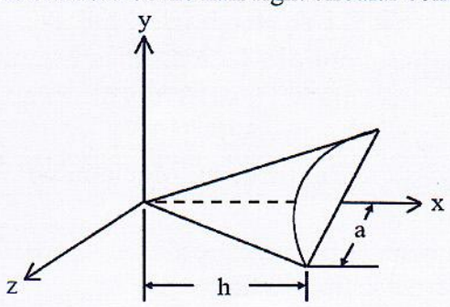
1(b) A 12-m pole supports a horizontal cable CD and is held by a ball and socket at A and two cables BE and BF. Knowing that the tension in cable CD is 14-kN and assuming that CD is parallel to the x-axis, determine the tension in cables BE and BF and the reaction at A. 17



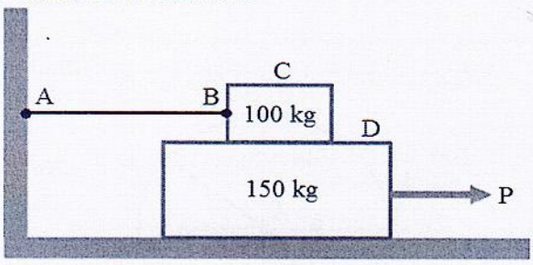
2(a) Find the centroid of the shaded area as shown. 17



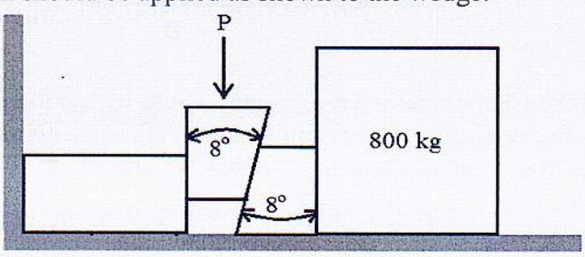
2(b) Determine the location of the centroid of the half right circular cone shown.



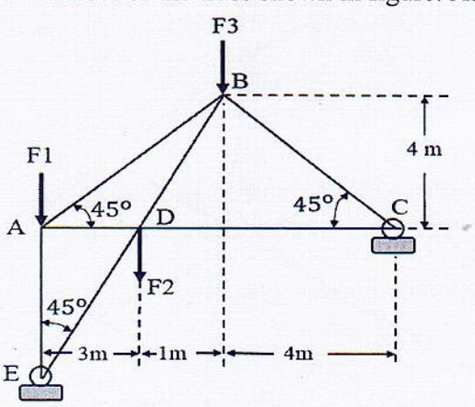
3(a) The co-efficients of friction are $\mu_s = 0.3$ and $\mu_k = 0.25$ between all surfaces of contact. Determine the smallest force P required to start block D moving if (i) block C is restrained by cable AB as shown, (ii) cable AB is removed. 18



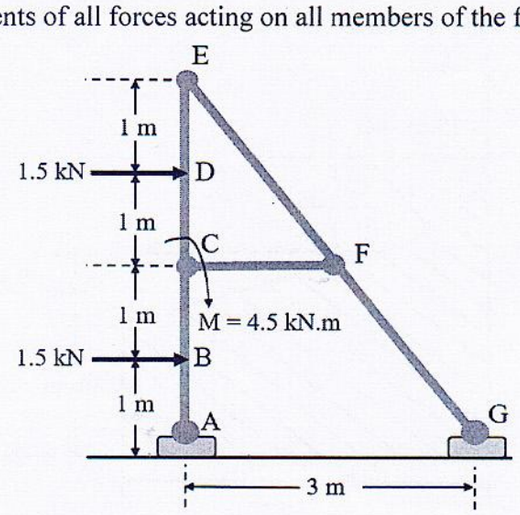
3(b) Two 8^0 wedges of negligible weight are used to move and position the 800 kg block. Knowing the co-efficient of friction $\mu_s = 0.3$ at all surfaces of contact, determine all the smallest force P which should be applied as shown to the wedge. 17



4(a) Determine the forces in each member of the truss shown in figure. Assume, $F_1=F_2=F_3=13$ kN. 18



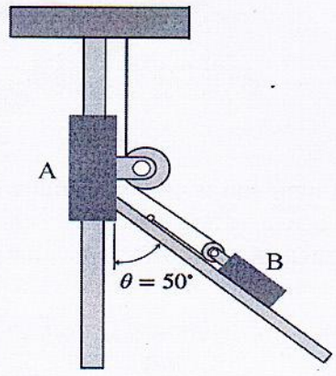
4(b) Determine the components of all forces acting on all members of the frame shown. 17



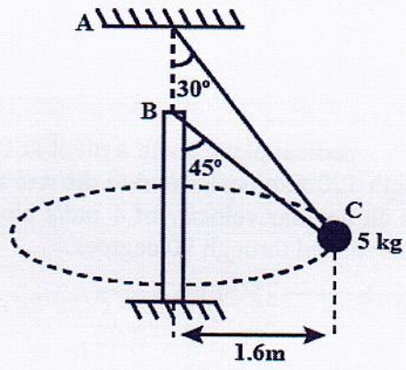
SECTION-B

5(a) An automobile at rest is passed by a truck travelling at a constant speed of 54 km/h. The automobile starts and accelerates for 10s at a constant rate until it reaches a speed of 90 km/h. If the automobile then maintains a constant speed of 90 km/h, determine when and where will it overtake the truck, assuming that the automobile starts (i) just as the truck passes, (ii) 3s after the truck has passed it. 17

5(b) Knowing that at the instant shown assembly A has a velocity of 9 in/s and an acceleration of 15 in/s^2 both directed downward, determine (i) the velocity of block B, and (ii) the acceleration of block B. 18



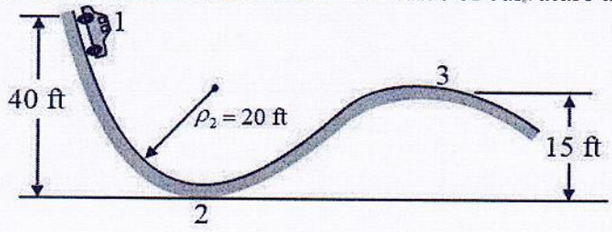
6(a) Two wires AC and BC are tied at C to a sphere which revolves at a constant speed v in the horizontal circle shown. Determine the range of the values of v for which wires remain taut. 17



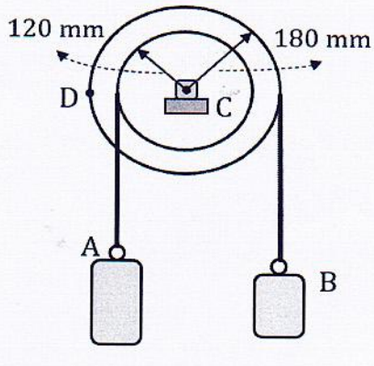
6(b) A 2000 lb car starts from rest at point 1 and moves without friction down the track shown. 18

(i) Determine the force exerted by the track on the car at point 2, where the radius of curvature of the track is 20 ft.

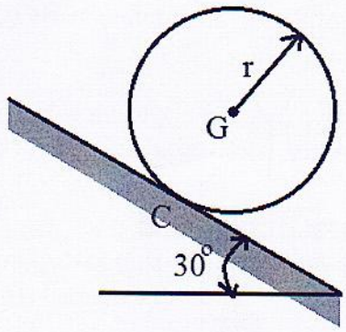
(ii) Determine the minimum safe value of the radius of curvature at point 3.



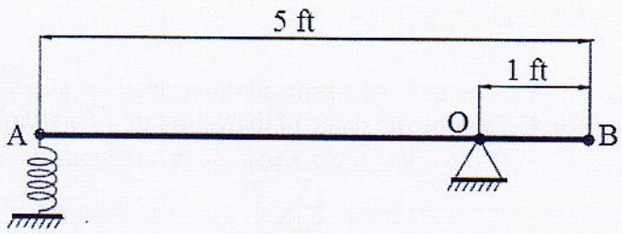
7(a) A pulley and two loads are connected by inextensible cords as shown. Load A has a constant acceleration of 300 mm/s^2 and an initial velocity of 240 mm/s, both directed upward. Determine (i) the number of revolutions executed by the pulley in 3s, (ii) the velocity and position of load B after 3s, and (iii) the acceleration of point D on the rim of the pulley at t=0. 17



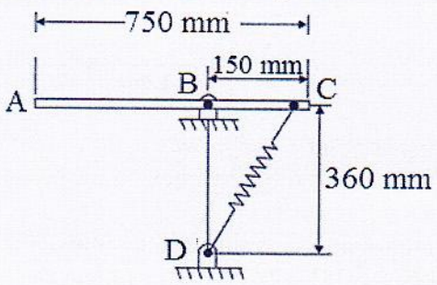
7(b) A sphere of radius r and weight W is released with no initial velocity on the incline and rolls without slipping. Determine (i) the minimum value of the co-efficient of static friction compatible with the rolling motion, (ii) the velocity of the center G of the sphere after the sphere has rolled 10 ft, and (iii) the velocity of G if the sphere were to move 10 ft down a friction less 30^0 incline. 18



8(a) A 30 lb slender rod AB is 5 ft long and is pivoted about a point O which is 1 ft from end B. The other end is pressed against a spring of constant k = 1800 lb/in until the spring is compressed 1 in. The rod is then in a horizontal position. If the rod is released from this position, determine its angular velocity and the reaction at the pivot O as the rod passes through a vertical position. 17



8(b) A 3-kg slender rod rotates in a vertical plane about a pivot at B. A spring of constant k = 300 N/m and of unstretched length 120 mm is attached to the rod as shown. Knowing that, in the position shown the rod has an angular velocity of 4 rad/s clockwise, determine the angular velocity of the rod after it has rotated through 90 degrees. 18



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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
MTE 2105
(Sensors and Instrumentations)

Time: 3 Hours | Total Marks: 210

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

SECTION-A

1(a) Define sensor and transducer. State three static and two dynamic characteristics of sensor with their defination. 14

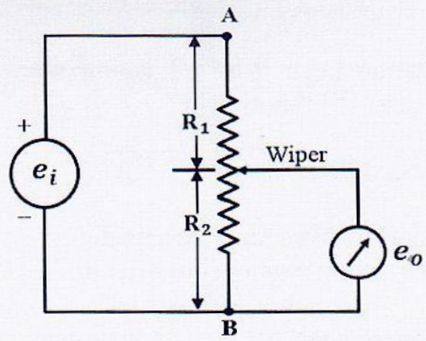
1(b) What is meant by accuracy as percentage of full scale and percentage of reading? Explain them with example. 10

1(c) Draw a block diagram showing the fundamental elements of a measurement system. Briefly describe each element. 11

2(a) Write down a relative comparison between LVDT, Ultrasonic and Optical sensors in displacement measurement. 09

2(b) Briefly describe how strain gauge can be attached to a specimen with necessary figure and describe its working principle. 10

2(c) A resistive displacement transducer with a shaft stroke 50 mm is shown in the following figure. The length of R_1 and R_2 is same but $R_1 = 100\ \Omega$ and $R_2 = 300\ \Omega$. The input voltage is 5 V and the output voltage is found to be 4 V. What is the position of the wiper from B? 08



2(d) What is direct and indirect piezoelectric effect? What are the advantages and disadvantages of piezoelectric sensor? 08

3(a) Mention some temperature measurement sensors. Briefly describe the working principle of a radiation pyrometer with appropriate figure. 12

3(b) Briefly describe the working principle of a finger point sensor with proper figure. What is its advantage over other types. 12

3(c) Briefly describe the construction of a thermistor with proper figure. What are the common types of thermistor according to its shape. 11

4(a) Define smart sensor. Why it is named so? 06

4(b) Define MEMS. Find out the governing equation of capacitive MEMS accelerometer. 15

4(c) Briefly describe the working principle of a tachometer with appropriate figure. Mention its application and disadvantages. 14

SECTION-B

5(a)	Briefly describe the working principle of synchro transmitter with proper figure.	14
5(b)	Two resistors R_1 and R_2 are connected in series with $R_1 = 28.7\ \Omega$ and $R_2 = 3.624\ \Omega$. Calculate the total resistance to the appropriate number of significant figures. Why significant figure is important in measurement?	06
5(c)	Draw and describe a basic sample and hold circuit. Also describe the successive approximation analog to digital conversion process.	15
6(a)	Define CMRR. Write down the physical significance of CMRR. Also design a circuit that acts as an integrator using Op-Amp.	10
6(b)	What is Modulation? Write down the purposes of modulation in signal transmission.	07
6(c)	'With Amplitude Modulation (AM), the bandwidth of the signal is doubled of baseband signal.' – Justify the statement.	10
6(d)	Design a high-pass LC filter with a load resistance of 1000 Ω and a cut-off frequency of 1000 Hz. What is the attenuation at one octave below the cut-off frequency?	08
7(a)	What is telemetry system? Why it is required? Draw the block diagram of a basic wire-link telemetry system.	12
7(b)	Differentiate between short-range radio telemetry system and satellite radio telemetry system.	08
7(c)	Describe the direct voltage telemetry system. What are the merits, demerits, and application of direct voltage telemetry system?	15
8(a)	Define virtual instrumentation (VI). Why VI is important in modern instrumentation? Describe the components of a VXI bus system.	10
8(b)	Differentiate between VXI and PXI.	08
8(c)	What are the key advantages of using an instrumentation amplifier in signal conditioning applications? How does an instrumentation amplifier differ from an operational amplifier?	12
8(d)	Discuss the methods to improve the CMRR of an instrumentation amplifier.	05

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