KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 2nd Year 1st Term Examination, 2023

EEE 2131

(Electronics)

Time: 3.00 Hrs. Total Marks: 210

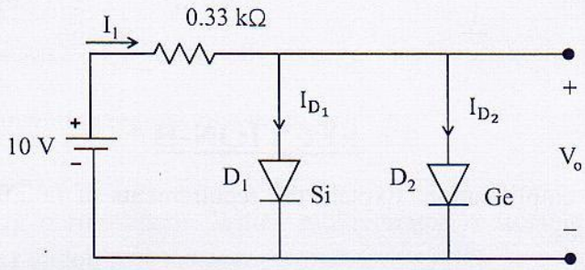
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

SECTION-A

1(a) Draw the I-V characteristics of a p-n junction with proper illustration and briefly explain it. 10

1(b) Differentiate between Zener breakdown and Avalanche breakdown of a p-n junction. How does Zener diode act as voltage stabilizer? 13

1(c) Determine V_o, I_1, I_{D_1}, and I_{D_2} for the following network. 12



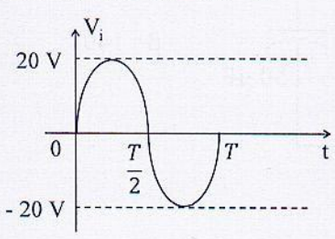
2(a) Define doping of semiconductor. How intrinsic semiconductor is converted into p-type and n-type semiconductor? Explain with neat sketch. 12

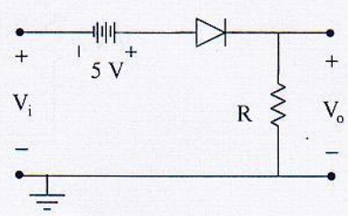
2(b) Explain the temperature dependence of the electron concentration in an n-type semiconductor with necessary diagrams and show the operating temperature range of the devices using such semiconductors. 12

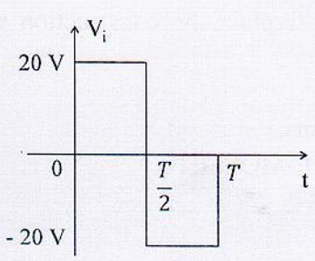
2(c) Find the resistance of a 1 cm^3 pure silicon crystal. What is the resistance when the crystal is doped with arsenic if the doping is 1 in 10^9 that is 1 part per billion (ppb)? Note that the atomic concentration in silicon is 5×10^{22} cm^{-3}, $n_i = 1.0 \times 10^{10}$ cm^{-3}, $\mu_e = 1400$ $cm^2V^{-1}S^{-1}$, and $\mu_n = 450$ $cm^2V^{-1}S^{-1}$ 11

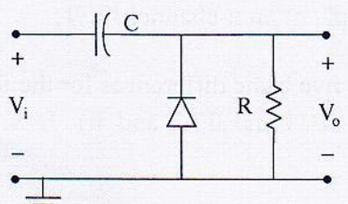
3(a) What is rectifier circuit? Why do we need rectification? Draw different diode rectifier circuits and their corresponding outputs. 10

3(b) Draw the output waveforms of the following networks shown in the following figure. Consider Si diode with $V_k = 0.7$ V. 15







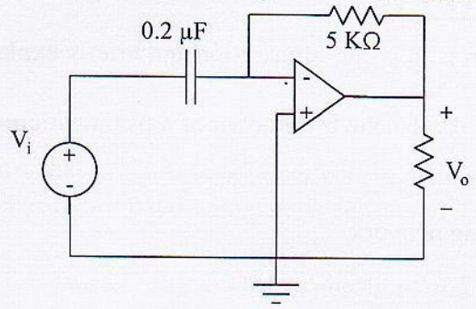


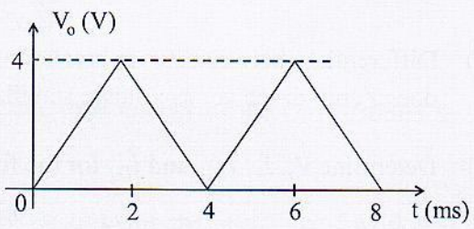
3(c) Briefly explain the following diodes with their equivalent circuits and application.
(i) LED (ii) Varacter diode (iii) Tunnel diode (iv) Photo diode

4(a) Define CMRR of an op amp. Derive the expression of volage gain of op amp based inverting amplifier, integrator, and differentiator. 12

4(b) Design a 1st order low pass passive filter using a single resistor (R_1 = 1.2 kΩ) and capacitor C_1 = 0.02 μF). Also, draw the frequency response of the filter. Note that voltage gain of the filter is 11. 12

4(c) Sketch the output voltage for the circuit in the following figure. Take V_o= 0 at t= 0. 11





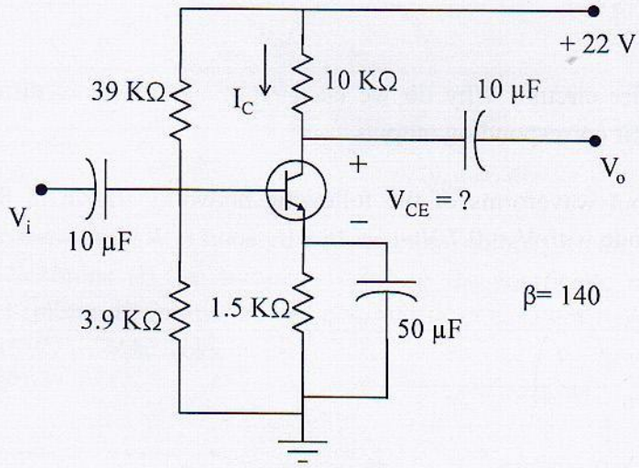
SECTION-B

5(a) Define faithful amplification. Explain the requirements of faithful amplification with proper schematics. 08

5(b) What is transistor biasing? Draw different transistor biasing circuits. Why mid-point biasing is good for an amplifier circuit. 15

5(c) For an n-p-n transistor, show that 12
i) $\beta = \frac{\alpha}{1-\alpha}$, ii) $I_C = \frac{\alpha}{1-\alpha} I_B + \frac{I_{CBO}}{1-\alpha}$, and iii) $S = \frac{\beta+1}{1-\beta\frac{dI_B}{dI_C}}$

6(a) For the circuit shown in the following figure determine the dc bias voltage V_{CE} and the current I_C. 11

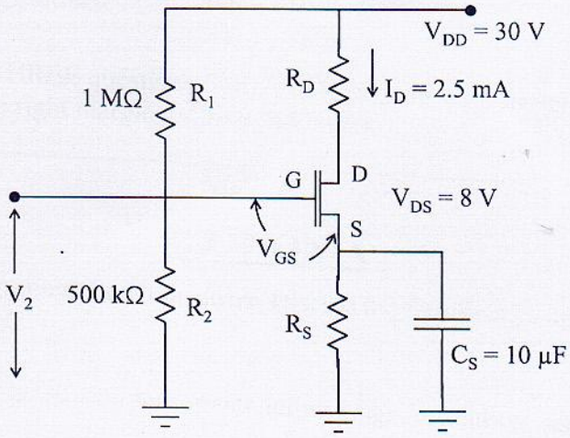


6(b) Why JFET is called a voltage control device? Explain the construction and working principle of an n-channel JFET. 12

6(c) Write five basic differences for the following items. 12
i) BJT and JFET and ii) D-MOSFET and E-MOSFET

7(a) Write the working principle and draw the I_D-V_{DS} curve and I_D-V_{GS} curve of an n-channel D-MOSFET. 10

7(b) In an n-channel JFET biased by voltage divider method as shown in the following figure, it is desired to set the operating point at I_D= 2.5 mA and V_{DS}= 8 V. If V_{DD}= 30 V, R_1= 1 MΩ, and R_2= 500 KΩ, find the value of R_S. The parameters of JFET are I_{DSS}= 10 mA and $V_{GS(off)}$= -5 V. 10



7(c) "Enhancement type MOSFET is normally an off device"- Justify the statement. 08

7(d) Explain different operating regions of a transistor. 07

8(a) Define and classify multivibrator. Which multivibrator is suitable for data storage? Explain with proper circuit. 11

8(b) Draw and explain the operating principle of an RC phase shift oscillator circuit. Also, derive its frequency equation. 10

8(c) What is meant by Timer IC? Draw the block diagram of a 555 Timer IC and briefly explain its different modes. 06

8(d) Draw two oscillator circuits, where feedback is based on LC components. 08

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 2nd Year 1st Term Examination, 2023

Hum 2131

(Engineering Economics and Accounting)

Time: 3.00 Hrs. 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.

SECTION-A

1 Suppose there are 10,000 identical individuals in the market for commodity X, each with a demand equation given by $\theta_{dx} = 12 - 2P_x$ and 1000 identical sellers, each with a supply equation given by $\theta_{sx} = 20P_x$. (P_x is given in dollar) 35

i. What is the law of demand and law of supply?
ii. Make a difference between demand schedule and demand curve.
iii. Explain the non-price factors that affect the supply.
iv. Obtain market equilibrium price and quantity from the mentioned equation.
v. What is the equilibrium price and quantity if tax z = $1 is imposed on per unit sold?

2(a) Define price elasticity of demand. List the determinants of price elasticity of demand. 20

2(b) What is cross-price elasticity of demand? Explain the following pairs of goods to be positive or negative? Explain your answer: 15

i. Coke and Fanta
ii. Printer and toner cartridge
iii. Air cooler and Vegemite

3(a) Define nominal GDP and real GDP. What are the various methods of calculating national income? Explain any one method. 15

3(b) Describe the reasons and consequences of inflation in a developing country like Bangladesh. What are your recommendations to control inflation of Bangladesh at the present condition? 20

4(a) What is the perfect competition market? Write down its characteristics. 05

4(b) Define short run. Show with the aid of graph the short-run equilibrium of a firm in perfect competition. 20

4(c) At what point a firm should shut down, explain with graph. 10

SECTION-B

5(a) Jon Snow is confused about how accounting information flows through the accounting system. He believes the flow of information is as follows:

i. Debit and credit posted to ledger.
ii. Business transactions occur.
iii. Information entered in the journal.
iv. Financial statements are prepared.
v. Trial balance is prepared.

Is Jon correct? If not, indicate to Jon the proper flow of the information.

5(b) What is basic accounting information? 10

5(c) What is transaction? Write down the characteristics of transaction. 10

6 On April 1, Adventures Travel Agency began operations. The following transaction were completed during the month: 35

April 1 : The owner invested $ 5000 in the business.
April 10 : Received cash for services provided $ 2600.
April 12 : Purchased equipment of $5000 by paying $ 2300 cash and the balance was on account.
April 25 : Services provided on account $ 1700
April 30 : Received $ 900 cash from customers billed on April 25.

Required:

i. Journalized the transactions of April.
ii. Post the transactions to ledger accounts.
iii. Prepare a trial balance as on April 30, 2023

7(a) Describe the basic rules of debit and credit of accounts. 15

7(b) ABM Industries Inc. had the following cost records for the year ending December 31, 2022: 20

Items	$	Items	$
Raw materials, 1/1/22	30,000	Property Taxes, Factory	6000
Raw materials, 31/12/22	20,000	Sales Revenue	15,00,000
Work in progress, 1/1/22	80,000	Delivery Expenses	100,000
Work in progress, 31/12/22	50,000	Sales Commission	150,000
Finished goods, 1/1/22	110,000	Administrative Expenses	300,000
Finished goods, 31/12/22	120,000	Indirect Labor	105,000
Direct labor	350,000	Factory Rent	40,000
Factory Manager's Salary	35,000	Factory Utilities	65,000
Insurance Factory	14,000	Depreciation Factory Building	24,000
Raw materials purchase	205,000		

Required:

i. Prepare a cost sheet for ABM Industries Inc.
ii. Prepare an income statement for ABM Industries Inc. for the year ended 2022

5. The following trail balance and adjustments are related to "A. Qasem & Co." as of 31 December 2023. 35

Qasem & Co.
Trail Balance
December 31, 2023

Name of accounts	Debit Tk.	Credit Tk.
Premises	121,000	
Capital and drawings	48,000	330,000
Office equipment	220,000	
Audit fees		870,500
Office rent	270,000	
Utilities expenses	8500	
Cash in hand	30,4000	
Advertisement	30,000	
Investment (Saving certificate)	200,000	
Dividend received		42,500
Conveyance	3600	
Advanced audit fees		60,000
Insurance expenses	6500	
Salary and wages	65000	
Bank deposit	300,000	
	13,03,000	**13,03,000**

Adjustment:

i) Audit of accounts is completed of an organization, of which bill 55,000 tk not yet received.
ii) Office rent is due for three months.
iii) Charge depreciation @10% on office equipment.

Required:

Prepare

i) Statement of comprehensive income
ii) Statement of owner's equity
iii) Statement of financial position

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B.Sc. Engineering 2nd Year 1st Term Examination, 2023

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 is missing.

SECTION-A

1(a) Define casual and noncausal systems with examples. Check whether the following systems are casual or not.. 12

(i) $y(t) = x(t^2)$
(ii) $y(n) = x(n) - x(n-1)$
(iii) $y(n) = nx(n)$

1(b) Define z-transform. Write down the important properties of the ROC (Region of convergence) for z-transform 11

1(c) Determine the z-transform of the signal $x(n) = a^n u(n) - b^n u(-n-1)$ where (a and b) < 1, b $<$ a and plot the ROC. 12

2(a) By applying time shifting property, determine the signal of $x(z) = \frac{(z^{-2}+\frac{1}{2}z^{-1})}{(1-\frac{1}{2}z^{-1})}$. 10

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

2(c) Solve the difference equation $y(k+2) - 18y(k+1) + 32y(k) = 0$ subject to $y(0) = 0$, $y(1) = 2$ using z-transform method. 13

3(a) Find the Laplace transform of (i) $t^2 e^t \sin 4t$ (ii) $\frac{1-\cos t}{t^2}$ 12

3(b) Find the inverse Laplace transform of $\frac{s^2}{(s^2+4)^2}$ using convolution theorem. 10

3(c) Solve the differential equation $y''(t) + y(t) = 8\cos t$ given that $y(0) = 1$, $y'(0) = -1$ using Laplace transform. 13

4(a) Using second shifting property find the Laplace transform of 08

$$g(t) = \begin{cases} (t-4)^3, t > 4 \\ 0 \quad\quad , t < 4 \end{cases}$$

4(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

4(c) Solve the integral transform 12

$$F(t) = e^{-t} - 2\int_0^t F(u)\cos(t-u)du$$

SECTION-B

5(a) Define Fourier series. Obtain the Fourier coefficients in the expansion of f(x) in $[-\pi, \pi]$

5(b) Find the Fourier series representing $f(x) = x;\ 0 < x < 2\pi$ and sketch its graph from $x = -4\pi$ to $x = 4\pi$. 12

5(c) By using the Fourier sine series for $f(x) = 1$; in $0 < x < \pi$ 10
Show that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots$

6(a) Find the Fourier sine and cosine transform of $f(x) = x^2 \quad 0 < x < 4$. 15

6(b) Define Parseval's identity. Write Parsival's identity corresponding Fourier series of the following function. 20

$$f(x) = \begin{cases} x, & 0 < x < 2 \\ -x, & -2 < x < 0 \end{cases}$$

7(a) Write the Fourier integral theorem. Using the Fourier integral of an even function, show that $\int_0^\infty \frac{\cos ux}{1+u^2} du = \frac{2}{\pi} e^{-x}, x > 0$ 10

7(b) Express the function $f(x) = \begin{cases} 1 & when\ |x| \le 1 \\ 0 & when\ |x| > 1 \end{cases}$ as a Fourier integral and hence evaluate 12
$\int_0^\infty \frac{\sin u \cos ux}{u} du$

7(c) Define Fourier sine and cosine transforms. Find the Fourier transform of 13

$$f(x) = \begin{cases} 1 - x^2, & |x| \le 1 \\ 0, & |x| > 1 \end{cases}$$

8(a) Solve $\frac{\partial U}{\partial t} = \frac{\partial^2 U}{\partial x^2}$ for $x > 0, t > 0$ subject to the conditions: $U(0, t) = 0$, 15
$U(x, 0) = \begin{cases} 1, & 0 < x < 1 \\ 0, & x \ge 1 \end{cases}$ and U(x, t) is bounded.

8(b) Determine the displacement of $y(x, t)$ of an infinite string which follows the given wave 20
equation $\frac{\partial^2 y}{\partial t^2} = K^2 \frac{\partial^2 y}{\partial x^2}$ satisfying the conditions (i) $y(x, 0) = f(x); f(x)$ is the initial displacement whereas $-\infty < x < \infty$ and (ii) $\frac{\partial y}{\partial t} = 0\ at\ t = 0$, using complex Fourier transform.

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 2nd Year 1st Term Examination, 2023

ME 2131

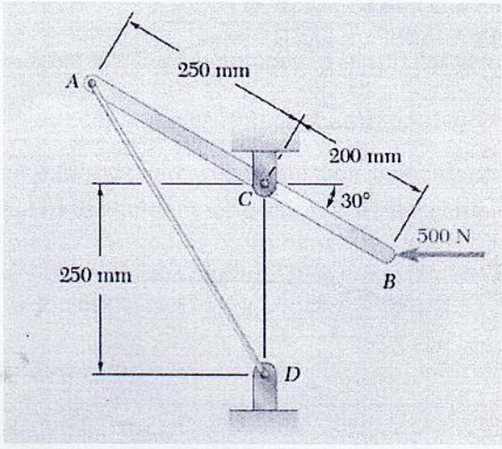
(Engineering Mechanics)

Time: 3.00 Hrs. Total Marks: 210

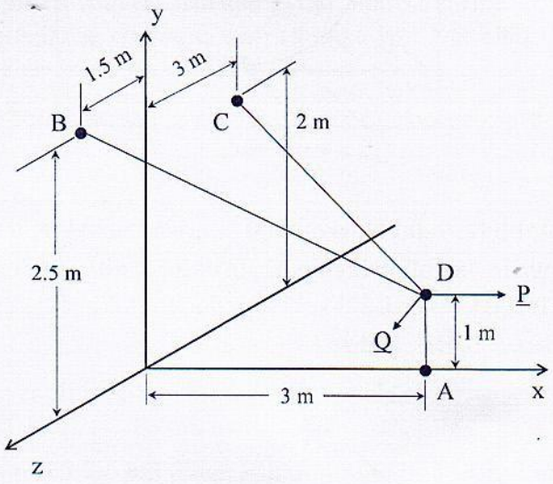
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

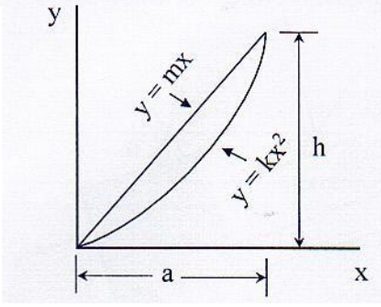
1(a) The lever AB is hinged at C and attached to a control cable at A. If the lever is subjected at B to a 500-N horizontal force, determine (i) the tension in the cable and (ii) the reaction at C. 18



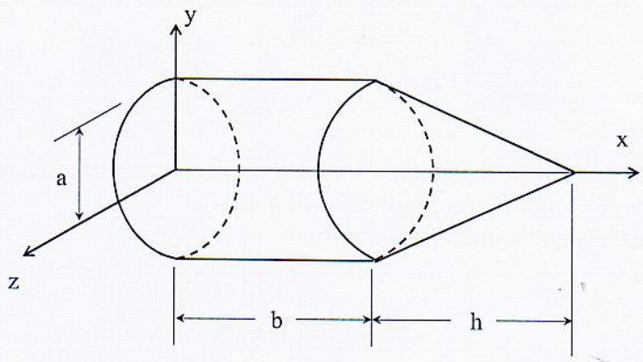
1(b) Three cables are joined at D where two forces P = (3.5kN) i and Q = (1.5kN) k are applied. Determine the tension in each cable. 17



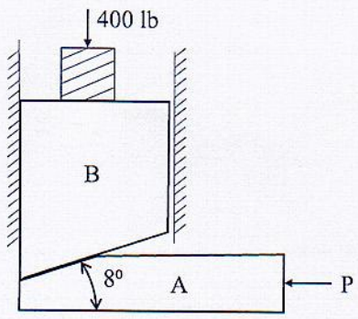
2(a) Determine by direct integration method, the centroid of the area shown. 17



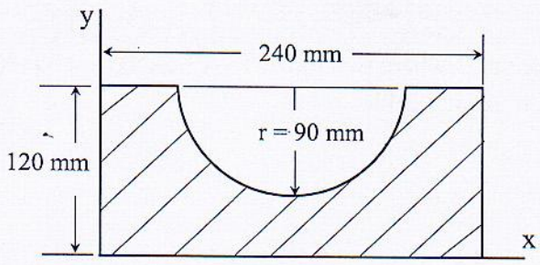
2(b) Determine the location of the centroid of the composite body shown in the following figure when h = 2b.



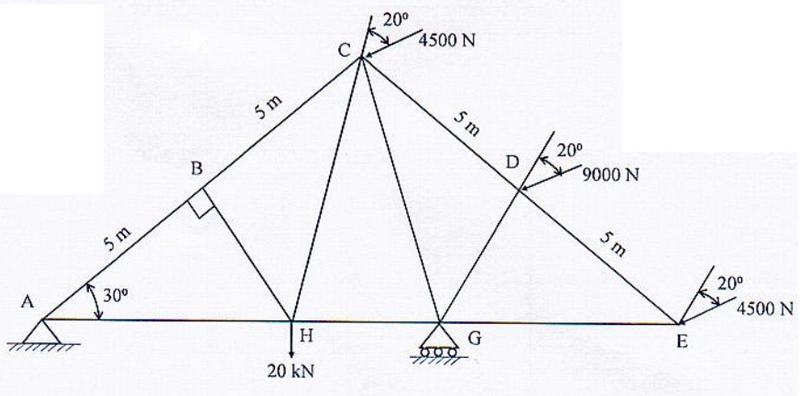
3(a) The position of machine block B is adjusted by moving wedge A. Knowing that the coefficient of static friction is 0.35 between all surfaces of contact, determine the force P required (i) to raise block B and (ii) to lower block B. 18



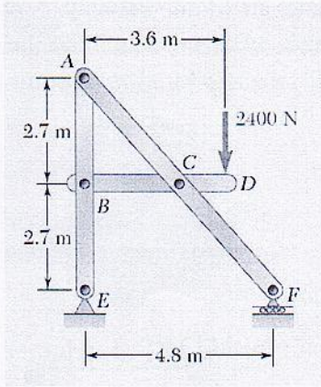
3(b) Determine the moment of inertia of the shaded area with respect to the x-axis. 17



4(a) The wind loads of 4500 N, 9000 N, and 4500 N are assumed to act on the pin joints of the roof truss as shown in the following figure. In order to allow for expansion, the support of G is on rollers. The 20 kN vertical load is applied to it. Find the external reactions and the forces on members BC, BH, and AH. 17



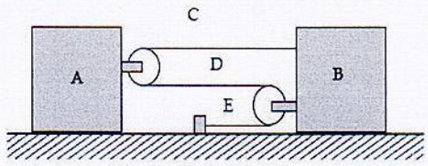
4(b) Determine the components of the forces acting on each member of the frame shown in the following figure. 18



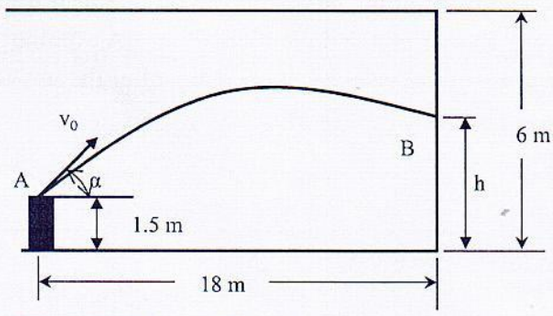
SECTION-B

5(a) What is motion curve? What are the advantages of graphical solution of rectilinear motion problems? 07

5(b) The slider block B moves to the right with a constant velocity of 18 m/s. Determine (i) the velocity of the block A, (ii) the velocity of portion D of the cable. 13

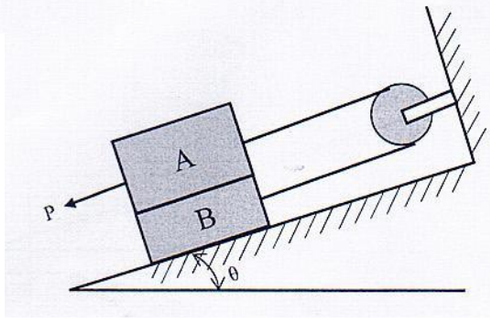


5(c) A player throws a ball with an initial velocity of 16 m/s from point A located 1.5 m above the floor. Knowing that the ceiling of the gymnasium is 6 m high, determine the highest point B at which the ball can strike the wall 18 m away. 15

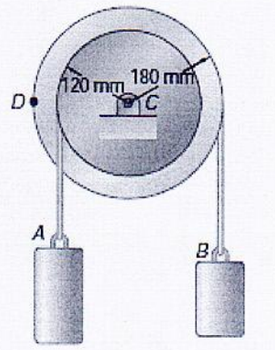


6(a) Explain the dynamic equilibrium of kinetics of particles. 05

6(b) Block A has a mass of 25 kg and block B has a mass of 15 kg. The coefficient of friction between all surfaces of contact are $\mu s = 0.20$ and $\mu k = 0.15$. Knowing $\theta = 25^{\circ}$ and the magnitude of the force P applied to Block A is 250 N, determine (i) the acceleration of Block A, and (b) the tension in the cord. 15



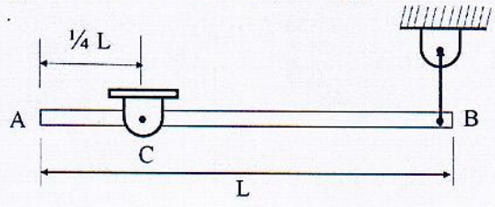
6(c) A pulley and two loads are connected by inextensible cords as shown. Load A has a constant acceleration of 300 mm/s^2 and an initial velocity of 240 mm/s, both directed upward. Determine (i) the number of revolutions executed by the pulley in 3 s, (ii) the velocity and position of load B after 3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



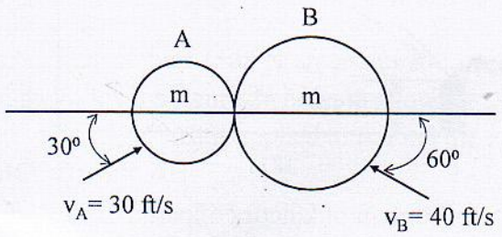
7(a) Show that in the case of a perfectly elastic impact, the total energy of the two particles as well as their total momentum is conserved. 13

7(b) Mathematically explain the applications and advantages of using the principle of work and energy. 07

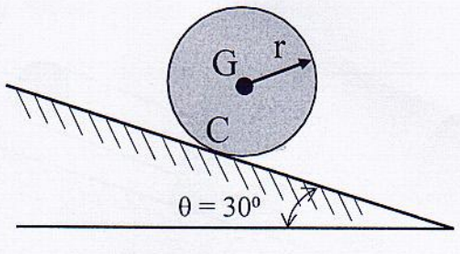
7(c) A slender rod of length L and weight W is supported as shown in the following figure. After the cable is cut the rod swings freely. Determine the angular velocity of the rod as if first passes through a vertical position and the corresponding reaction at the pin support. 15



8(a) The magnitude and direction of the velocities of two identical frictionless balls before they strike each other are shown in the following figure. Assuming e = 0.90, determine the magnitude and direction of the velocity of each ball after the impact. 17



8(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 coefficient 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, (iii) the velocity of G if the sphere were to move 10 ft down a frictionless 30° incline. 18



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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 2nd Year 1st Term Examination, 2023

MTE 2105

(Sensors and Instrumentations)

Time: 3.00 Hrs. 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.

SECTION-A

1(a)	Differentiate between sensor and transducer. Discuss the significance of calibration in sensor measurement.	09
1(b)	Draw a characteristic graph of a sensor and define range, resolution, sensitivity, dead band, and zero offset.	10
1(c)	Suppose you are building a mobile robot for household activities. Which displacement measurement sensor do you want to use to avoid collision? Explain its working principle with necessary sketch.	08
1(d)	Briefly explain the working principle of a sensor used as a proximity sensor to detect magnetically conductive target.	08
2(a)	Explain the working principle of a sensor used to measure the angular displacement of a rotating shaft with counting the number of turns.	12
2(b)	Describe the working principle of the temperature measurement sensors constructed with two different metals.	15
2(c)	Give a comparison of RTD and thermistor.	08
3(a)	Explain the working principle of a non-contact temperature measurement sensor.	10
3(b)	What are the sensors widely used to measure fluid flow rate? Explain the working principle of a variable area flow meter.	13
3(c)	How is the ultrasonic flow meter used to measure fluid flow rate? Describe with necessary sketch.	12
4(a)	Describe the working principle of a strain gauge sensor. How is it used to measure strain in materials? What factors affect its accuracy?	12
4(b)	Describe a power absorption type dynamometer with neat sketch.	10
4(c)	Briefly explain the working principle of the zero-compliance mechanism in force measurement.	13

SECTION-B

5(a)	What is data transmission? Describe asynchronous data transmission.	
5(b)	What is modulation? Write down the purposes of modulation in signal transmission.	07
5(c)	Design a circuit that acts as an integrator using op-amp.	10
5(d)	A balanced output source provides a signal of 30 mV from each terminal to the ground. This provides a difference signal of 60 mV for a difference amplifier. The noise signal common to both terminals is 600 mV. The differential gain of the amplifier is 150, while the common mode gain is 0.04. What is the ratio of signal to noise at the output?	10
6(a)	Draw and describe a basic sample and hold circuit. Also, describe the successive approximation analog to the digital conversion process.	12
6(b)	How can the accuracy of an ADC be improved?	10
6(c)	State and explain the Nyquist-Shannon theorem of sampling.	05
6(d)	A bandpass filter consists of two RC networks connected in a cascade. The low pass filter consists of a resistor $R_1 = 10\ k\Omega$ and $C_1 = 100$ PF and the high pass filter consists of $R_2 = 1\ M\Omega$ and $C_2 = 0.01\ \mu F$. Find the lower and upper cutoff frequencies and passband gain.	08
7(a)	What is a telemetry system? Explain how telemetry systems are used in healthcare for remote patient monitoring.	10
7(b)	Compare and contrast wired and wireless telemetry systems.	10
7(c)	Describe the single-channel digital telemetry system with necessary diagram. Also, mention its merits, demerits, and applications.	15
8(a)	Define virtual instrumentation (VI). Describe the two popular modular instrumentation techniques in detail.	13
8(b)	Describe the basic components of a VXI bus system.	07
8(c)	What is ADC? Explain the steps of analog to digital data conversion.	15

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