KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B.Sc. Engineering 2nd Year 1st Term Examination, 2021
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)   What is meant by electronics? Why semiconductors are the materials of choice for electronic devices?   10

1(b)   What is an ideal diode? From Shockley's equation, draw the V-I characteristic curve of a semiconductor diode and identify the significant regions on the curve with approximate scaling.   08

1(c)   Define transition and diffusion capacitances. Also, plot the C-V characteristic curve of a Si diode.   08

1(d)   Draw the output waveforms of the following networks shown in figure below. For each of the networks, the input is a sinusoidal waveform of 20V (p-p).   09
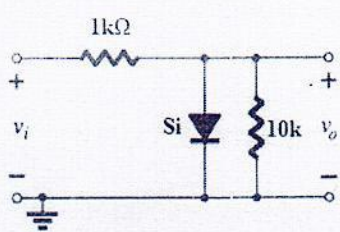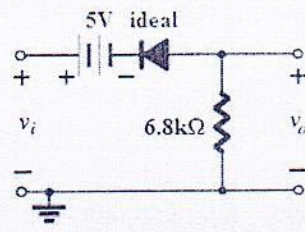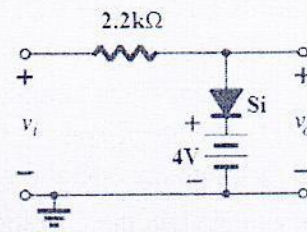

(i)   (ii)   (iii)

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

2(b)   What is compensation doping? Specify the two possible compensation effects in a semiconductor.   05

2(c)   Explain the temperature dependence of the electron concentration in an n-type semiconductor.   10

2(d)   The density of states related to effective masses of electrons and holes in Si are approximately $1.08m_e$ and $0.60m_e$, respectively and the electron and hole drift mobility at room temperature are 1400 $cm^2V^{-1}s^{-1}$ and 450 $cm^2V^{-1}s^{-1}$, respectively. Calculate the intrinsic concentration and intrinsic resistivity of Si.   10

3(a)   What do you mean by rectifier circuit? Draw different diode rectifier circuits and their corresponding outputs. Also mention advantages and disadvantages of each of them.   13

3(b)   Define ripple factor. Briefly explain different filter circuits that are used to remove ripple from rectified output signals.   11

3(c)   What do you mean by a zener diode? A zener regulator circuit is shown below. What is the range of V_i to operate the circuit? What will happen if V_i is out of range?   11
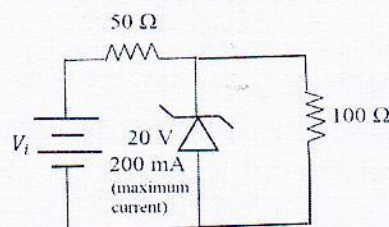

4(a)   What is an op-amp? Draw the circuit diagrams and frequency responses of second-order low pass and high-pass active filters using op-amp.   08

4(b) What is a multivibrator? What are the different types of multivibrators? Briefly explain each   05
of them.

4(c) What is an oscillator? Mention the advantages of electronic oscillators.   10

4(d) With a neat sketch, explain the operational principle of Colpitt's oscillator. Also determine   12
the operating frequency and feedback fraction if the values of tank circuit components are
$C_1 = 0.001\ \mu F$, $C_2 = 0.01\ \mu F$, and $L = 15\ \mu H$.

SECTION-B

5(a) What is a BJT? Explain the construction and operation of a transistor.   09

5(b) Briefly explain the different operating regions of a transistor. Show that a transistor can   09
be used as a switch.

5(c) Why the midpoint biasing is a good choice to use a transistor as an amplifier? Explain   09
with suitable diagram.

5(d) For the collector feedback configuration below, determine I_{BQ}, I_{CQ}, and V_{CEQ}.   08
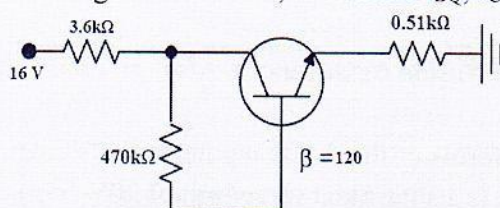
6(a) Write a comparison between   08
    i) BJT and FET
    ii) D-MOSFET and E-MOSFET

6(b) Briefly explain the operation of a D-MOSFET.   11

6(c) Draw and explain the operation of a CMOS inverter.   10

6(d) Sketch the transfer curve for a p-channel JFET with $I_{DSS} = 4mA$ and $V_p = 3V$.   06

7(a) Write a short note on op-amp characteristics. Show that an op-amp can be used as   10
    i) Summing amplifier
    ii) Integrator
    iii) Differentiator

7(b) Design a network using minimum number of op-amps to perform the following operation: 09

$$V_0 = -9V_1 - 8V_2 + 6\frac{dV_3}{dt}$$

7(c) What is slew rate? For an op-amp having slew rate of $2V/\mu s$, what is the maximum closed-   10
loop voltage gain that can be used when the input signal varies by $0.5V$ in $10\ \mu s$?

7(d) Determine the output voltage for the circuit shown below.   06
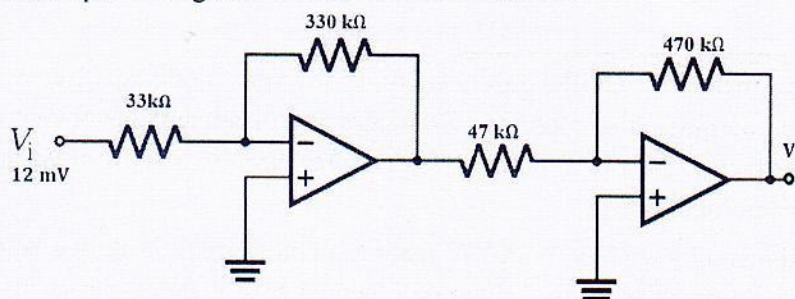
8(a) Explain a transistor as an amplifier circuit.   07

8(b) Briefly explain op-amp offset voltages.   10

8(c) What do you mean by transistor modeling? Draw different types of transistor biasing   10
circuits and their corresponding AC equivalent circuits using transistor small signal
model.

8(d) Briefly discuss the effect of load and source impedances on transistor's voltage gain.   08

— × —

SECTION-A

1(a)   Define Economics. Distinguish between Microeconomics and Macroeconomics.   10

1(b)   Define opportunity cost. Use a production possibilities frontier (PPF) to illustrate economy's   10
trade-off between high income and clean environment.

1(c)   Solve the following problems: 15
There are 10000 identical individuals in the market for commodity X, each with a demand
function given by $\theta_{dx} = 12 - 2P_x$ and 1000 identical producer of X, each with a supply
function given by $\theta_{sx} = 20P_x$.
i) Obtain equilibrium price and quantity.
Now if the government decides to collect a sales tax of $2 per unit sold from each of the
1000 sellers of commodity X,
ii) What effect does this have on the equilibrium price and quantity?
iii) What is the total amount of taxes collected by the government?

2(a)   Define total cost, average total cost and marginal cost.   05

2(b)   Define short run. How does a firm in a perfectly competitive market finds the best level of   20
output?

2(c)   What is meant by closing down point? Explain with figure on the basis of perfect competitive   10
market in the short run.

3(a)   Define price elasticity of demand. What are the determinants of price-elasticity of demand?   15

3(b)   What is income elasticity of demand? Would you expect the cross-price elasticity between   20
the following pairs of goods to be positive or negative? Explain your answers:
    i) Coke and Pepsi
    ii) DVD players and DVDs
    iii) Gucci sunglasses and vegemite

4(a)   Define national income. What are the methods of calculating national income? Explain   20
income method of national income accounting.

4(b)   To control inflation, how do the control bank control the credit creation capacity of the   15
commercial banks?

SECTION-B

5(a)   Define cost accounting. Distinguish between cost accounting and financial accounting.   20

5(b)   Who are the users of accounting information?   07

5(c)   Distinguish between book keeping and accounting.   08

6(a)   What is journal? Why it is called the book of original entry?   10

6(b) Journalize the following transactions in the book of Arnold company: 2

June 1: Mr. Arnold invested cash tk. 1,00,000 and a building valuing tk. 5,00,000 to start the business.

June 5: Purchased an equipment on credit for tk. 20000 making one-fourth down payment.

June 10: Paid tk. 8000 as two month's insurance premium in advance.

June 15: Made a partial payment of tk. 1000 on the equipment purchased on June 5.

June 20: A customer has been billed with tk. 2000 for the services provided.

June 25: Mr. Arnold withdrew tk. 1500 for his personal need

June 30: Paid utilities bill tk. 12,000 for the month of June.

June 30: Transfer one month's insurance to insurance expense account.

7(a) What is trial balance? What are the errors that cannot be detected by trial balance? 10

7(b) Various cost and sales data for Zonus cable manufacturing company for the just completed year are given below: 25

Items	Taka
Finished goods inventory, beginning	20,000
Finished goods inventory, ending	10,000
Depreciation, factory	7,000
Administrative expenses	12,000
Utilities, factory	8,000
Maintenance, factory	40,000
Supplies, factory	9,000
Sales	5,00,000
Selling expenses	80,000
Insurance, factory	4,000
Purchase of raw materials	90,000
Raw materials inventory, beginning	9,000
Raw materials inventory, ending	6,000
Direct labor	70,000
Indirect labor	15,000
Work in process, beginning	27,000
Work in process, ending	17,000

Requirement: Prepare a schedule of cost of goods manufactured

8. Following is the trial balance of ABC Fashion on December 31, 2021: 35

Name of accounts	Debit (Tk.)	Credit (Tk.)
Cash	80,000	
Inventory (1-1-21)	1,70,000	
Purchase	7,35,000	
General expenses	72,500	
Selling expenses	91,500	
Interest expenses	5,000	
Drawing	50,000	
Accounts Receivable	13,000	
Building	2,50,000	
Sales discount	8,500	
Accumulated depreciation		30,000
Salary payable		3,000
Accounts payable		42,500
Loan		1,00,000
Sales		9,95,000
Capital		3,00,000
Purchase discount		5,000
TOTAL	14,75,500	14,75,500

Adjustment:

i) Inventory as on December, 2021 is tk. 1,50,000

Requirements:

i) Prepare as income statement for the year ended December 31, 2021

ii) Prepare a balance sheet as on December 31, 2021

— × —

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B.Sc. Engineering 2nd Year 1st Term Examination, 2021
Math 2131
(Fourier Analysis and Laplace Transform)

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) Define periodic and aperiodic signal. Check whether the following signals are periodic or not. If yes, find its fundamental period.   **10**

   i) $x_1(t) = cost + \frac{1}{3}cos2t + \frac{1}{2}cos\left(\frac{t}{3}\right)$

   ii) $x_2(t) = -1.2 - 2sin2.1t + 3cos2.8t$

1(b) Obtain the Fourier series for the expansion of $f(x) = x + x^2$ in the interval $-\pi < x < \pi$ and hence deduce that $\frac{\pi^2}{6} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots$ **18**

1(c) Write down the conditions for the convergence of Fourier series.   **07**

2(a) Write down the assumption for the validity of Fourier series expansion. Find a series of sine and cosine multiple of x which represent $x + x^2$ in the interval $-\pi < x < \pi$ and deduce that, $\frac{\pi}{6} = \sum_{n=1}^{\infty} \frac{1}{n^2}$ **20**

2(b) Define odd and even function. If $f(t) = t^2$; $0 < t < 1$, then find its half range Fourier sine series.   **15**

3(a) Write down some important properties of Fourier series.   **06**

3(b) Define Parseval's identity. Write Parseval's identity corresponding Fourier series of the function $f(x) = \begin{cases} x, & 0 < x < 2 \\ -x, & -2 < x < 0 \end{cases}$ **17**

3(c) State Fourier integral theorem. 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 $\int_0^\infty \frac{sin\lambda cos\lambda x}{\lambda} d\lambda$ **12**

4(a) Find the Fourier sine transform of the function $f(x) = \frac{e^{-ax}}{x}$ **10**

4(b) Solve $\frac{\delta u}{\delta t} = k \frac{\delta^2 u}{\delta x^2}$ for $x \ge 0$, $t \ge 0$ under the given conditions $u = u_0$ at $x = 0, t > 0$ with initial conditions $u(x, 0) = 0, x \ge 0$ **15**

4(c) Show that $f(x) = e^{\frac{-x^2}{2}}$; $-\infty < x < \infty$ is self-reciprocal under Fourier transform.   **10**

SECTION-B

5(a) Define integral transform and hence find the kernel of the transform. Also find the kernel of Laplace transform.   10

5(b) Define causal and non-causal system with example. Check whether the following systems are causal or not.   10

$$\text{i) } y(t) = tx(t) \qquad \text{ii) } y(t) = x(sint)$$

5(c) Define z-transform. Determine the z-transform of the following signal and plot the ROC.   15
$$x(n) = a^n u(n) - b^n u(-n-1); (a, b < 1, b > a)$$

6(a) What do you mean by region of convergence? Write down the important properties of the ROC for z-transform.   11

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

6(c) Find the inverse z transform of $x(z) = \dfrac{z+0.5}{(z+0.8)(z+0.6)}; |z| > 0$ by using residue method.   14

7(a) Solve the following difference equation $y(k+2) - 18y(k+1) + 32y(k) = 0$, subject to $y(0) = 0,\ y(1) = 2$ by using z-transform method.   14

7(b) Find the Laplace transform of $f(t) = te^{2t} sin3t$ 10

7(c) Solve the integral equation using Laplace transform where,   11

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

8(a) Using scaling property, find the Laplace transform of $f(t) = sin4t$ 09

8(b) Find the inverse Laplace transform of $\dfrac{2s^2-4}{(s+1)(s-2)(s-3)}$ using Heaviside expansion formula.   11

8(c) Solve the differential equation $y''(t) + 4y(t) = 9t$, given that $y(0) = 0,\ y'(0) = 7$ using Laplace transform method.   15

— × —

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B.Sc. Engineering 2nd Year 1st Term Examination, 2021
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)   Two spheres are at rest against smooth surfaces as shown in figure. Sphere A weighs 1450   17
       kg and sphere B weighs 180 kg. Let the horizontal force F be 4460 N and $v = 75°$. Find
       the reactions at C, D and E.
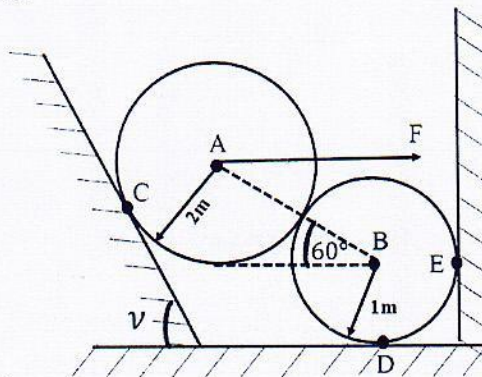
1(b)   A container is supported by three cables as shown. Determine the weight W of the   18
       container, knowing that the tension in cable AB is 500 N.
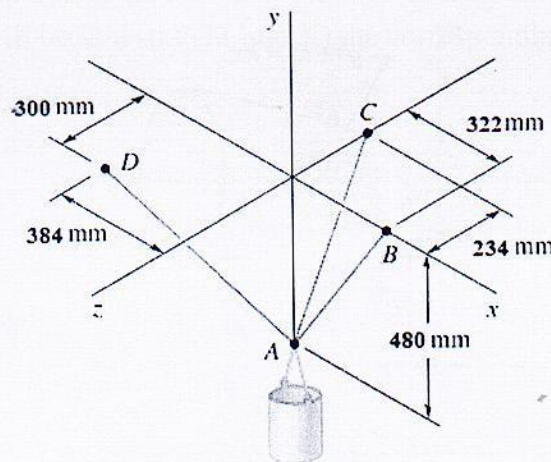
2(a)   For the plane area shown below, determine the first moments with respect to x and y axes   17
   and then find the location of the centroid.
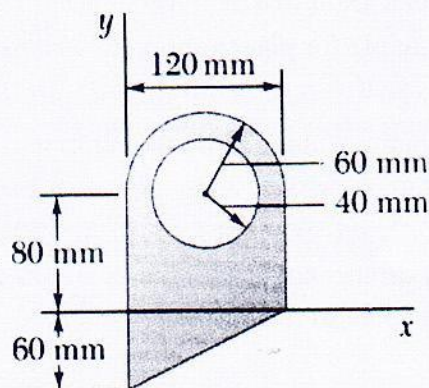
2(b) Determine by direct integration method, the centroid of the area shown.
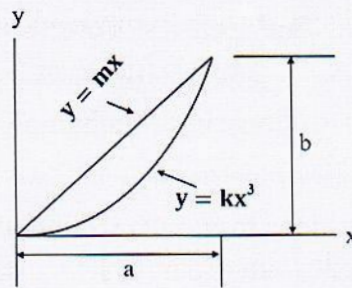

3(a) Derive an expression for the ratio of tensions in flat belt.   17

3(b) Two 10° wedges of negligible weight are used to move and position the 163 kg block.   18
Knowing that the coefficient of static friction at all surfaces of contact is 0.25, determine
the smallest force P that should be applied as shown to one of the wedges.
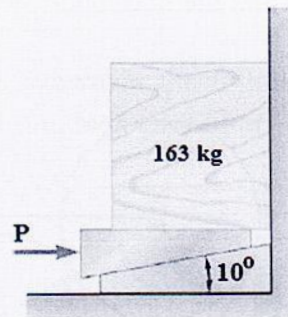
4(a) Establish the mathematical model of parallel axes theorem.   17

4(b) Determine by direct integration the mass moment of inertia and the radius of gyration   18
with respect to the y axis of the paraboloid shown, assuming a uniform density and a mass
m.
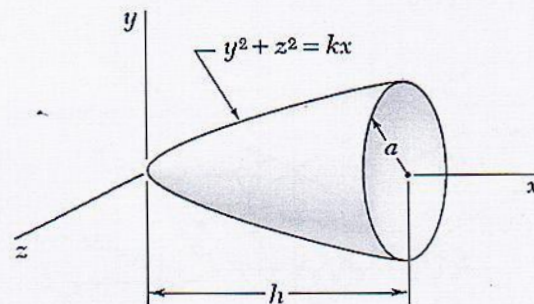
SECTION-B

5(a) What is mechanics? How is it classified?   5

5(b) Explain D' Alembert's principle for plane motion of a rigid body with necessary sketch.   7

5(c) What is the difference between particle and rigid body considerations in dynamics?   5

5(d) The rotation of rod OA about O is defined by the rotation $\theta = 2t^2$, where θ is expressed in   18
radians and t in seconds. Collar B slides along the rod in such a way that its distance from O
is $r = 60t^2 - 20t^3$, where r is expressed in inches and t in seconds. When $t = 1s$,
determine i) the velocity of the collar, ii) the total acceleration of the collar, iii) the
acceleration of the collar relative to the rod.
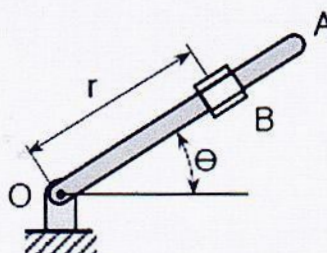
6(a) The coefficients of friction between blocks A and C and the horizontal surfaces are $\mu_s = 0.24$ and $\mu_k = 0.20$. Knowing that $m_A = 5kg$, $m_B = 10kg$, and $m_C = 10kg$, determine i) the tension in the cord and ii) the acceleration of each block. 18
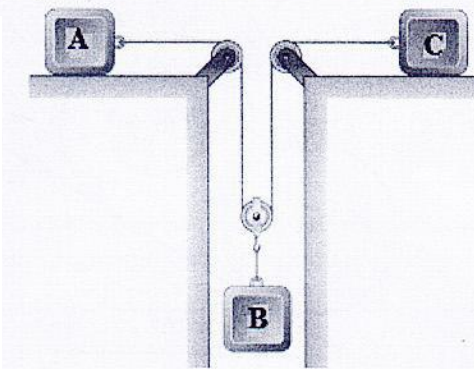

6(b) A 2 kg block is at rest on a spring of constant 400 N/m. A 4.5kg block is held by a rope above the 2kg block so that it just touches it. The rope is suddenly cut. Determine i) the maximum velocity attained by the blocks and ii) the maximum force exerted on the blocks. 17
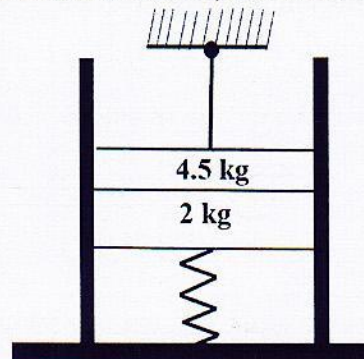

7(a) A uniform rod BC of mass 4 kg is connected to a collar A by a 250 mm cord AB. Neglecting the mass of the collar and cord, determine i) the smallest constant acceleration a_A for which the cord and the rod will lie in a straight line. ii) the corresponding tension in the cord. 18
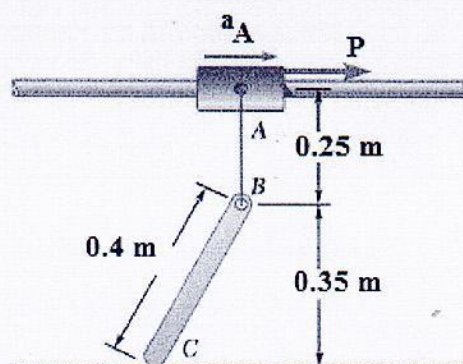

7(b) Two 500 mm rods are pin-connected at D as shown. Knowing that B moves to the left with a constant velocity of 360 mm/s, determine at the instant shown i) the angular velocity of each rod and ii) the velocity of E. 17

Dimensions in mm
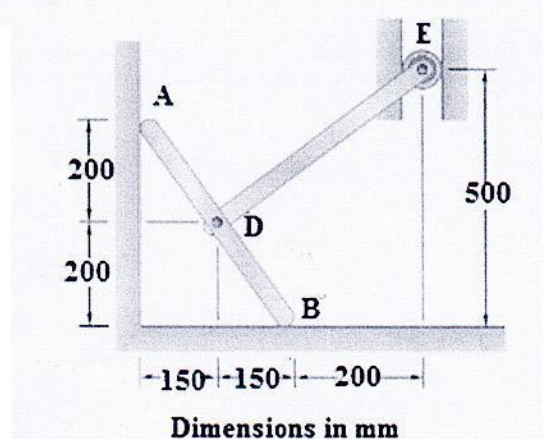
8(a)   A homogenous cylinder C and a section of pipe P are in contact (figure shown below) when   17
       they are released from rest. Knowing that both the cylinder and the pipe roll without slipping,
       determine the clear distance between them after 3 sec.

$\beta = 15°$
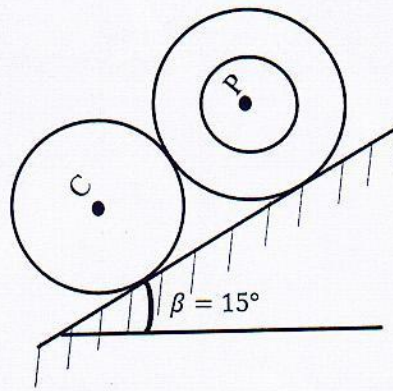
8(b)   A slender rod of length L and weight W is supported as shown. After the cable is cut, the   18
       rod swings freely. i) Determine the angular velocity of the rod as it first passes through a
       vertical position and the corresponding reaction at the pin support. ii) Solve part (i) for
       W = 6 lb and L = 2.5 ft.

¼ L
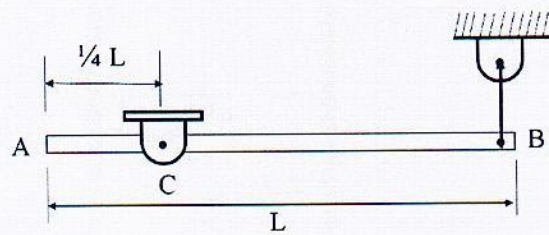
A

C

B

L

— × —

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechatronics Engineering
B.Sc. Engineering 2nd Year 1st Term Examination, 2021
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) Define sensor and transducer. Classify transducer based on principle of transduction and based on output. Briefly describe the selection criteria of a transducer for a measurement. 12

1(b) Describe a system with appropriate figure where both primary and secondary transducer are used to measure a physical quantity. 15

1(c) Mention a transducer which can also act as an inverse transducer. Briefly describe the process. 08

2(a) Briefly describe common types of errors associated with measurement, its sources and remedy. 14

2(b) Define accuracy, true value, calibration and precision. 08

2(c) In a deflection type Wheatstone bridge arrangement shown in figure, the resistances of various arms are P=1000 Ω, Q=100 Ω, R=2005 Ω, and S=200 Ω. The battery has an emf of 5 V. The voltmeter used to the arrangement has span 0 V to 5 V, sensitivity of 20000 Ω/V and resolution of 1 mV.
i) What will be the voltage difference between point a and b?
ii) What will be the voltmeter reading?
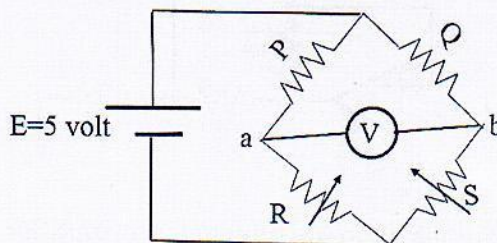iii) How the bridge can be balanced? 09


Figure: Deflection type Wheatstone bridge circuit

2(d) How temperature can be compensated in a strain gauge arrangement? 04

3(a) What is loading effect? Briefly describe the loading effect on a potentiometer connected with a voltmeter. 10

3(b) What is LVDT? Describe the working principle of a LVDT with appropriate figure. Mention its advantages and disadvantages. 15

3(c) Briefly describe how strain gauge can be attached to a specimen with proper figure. 10

4(a) Define smart senor. What are the basic elements of a smart sensor? 06

4(b) Draw the schematic diagram of an error detecting synchro. 08

4(c) Find out the relation between flow rate and displacement of a bob in a rotameter. 15

4(d) A moving coil voltmeter has a uniform scale with 100 divisions, the span is 50 to 250V and 1/10 of a scale division can be estimated. Determine the range, resolution and accuracy of the instrument. 06

SECTION-B

5(a) What is data transmission? Describe asynchronous data transmission.   08

5(b) What is telemetry system and where and why telemetry is required? Draw the block   12
diagram of a telemetry system.

5(c) Briefly describe the satellite radio telemetry system with proper block diagram.   15

6(a) Explain the importance of data conversion devices in mechatronic system with suitable   10
example.

6(b) A sensor gives a maximum analog output of 5 V. What word length is required for an   10
ADC if there is to be a resolution of 10 mV?

6(c) Describe the direct current telemetry system. What are the merits, demerits and   15
application of direct current telemetry system?

7(a) Determine what type of filter is shown in the following figure. Calculate the corner   15
frequency, f_c. Draw a passive low and high pass filter.
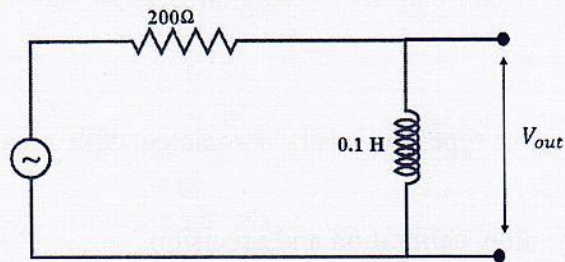
7(b) Determine V_{out} in following figure if V_{in+} = 20 mV DC and V_{in-} = −10 mV DC.   10
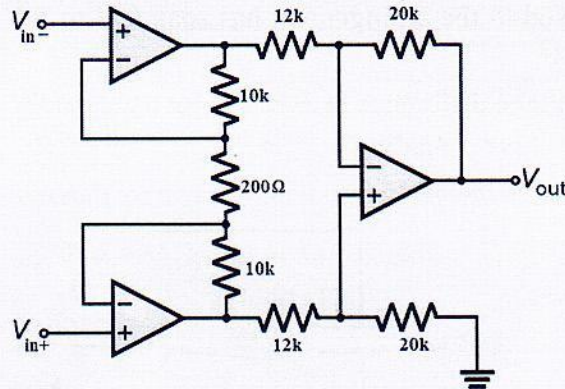
7(c) Give at least two applications of an instrumentation amplifier.   05

7(d) What are the advantages and disadvantages of optical sensor over LVDT?   05

8(a) Mention some temperature sensors. Briefly describe the working principle of a   18
thermocouple with appropriate figure. Mention why it is different from RTD and
thermistor?

8(b) What is MEMS? Briefly describe the working principle of a capacitive MEMS   12
accelerometer.

8(c) Why three wire configuration of RTD is better than two wire configuration?   05

— × —