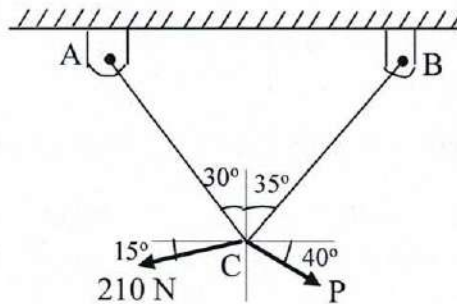


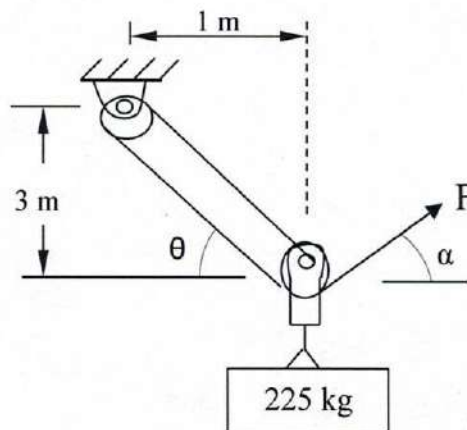
- N.B.:** i) Answer any THREE questions from each section in separate scripts.
 ii) Figures in the right margin indicate full marks.
 iii) Assume reasonable data if any missing.

SECTION-A

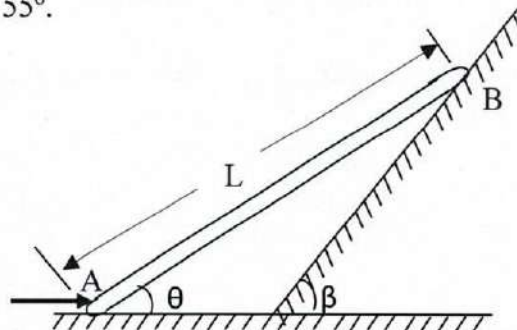
- 1(a) Two cables AC and BC are tied together at C. Knowing that $P = 300$ N, determine the tension in cables AC and BC. 10



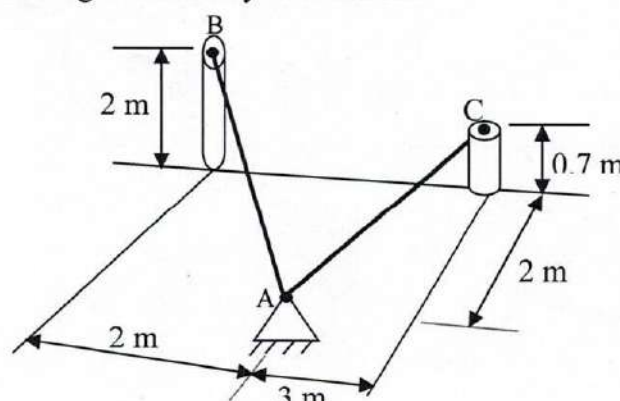
- 1(b) A crate is to be supported by the rope-and pulley-arrangement as shown below. Determine the magnitude and direction of the force F which should be exerted on the free end of the rope. 12



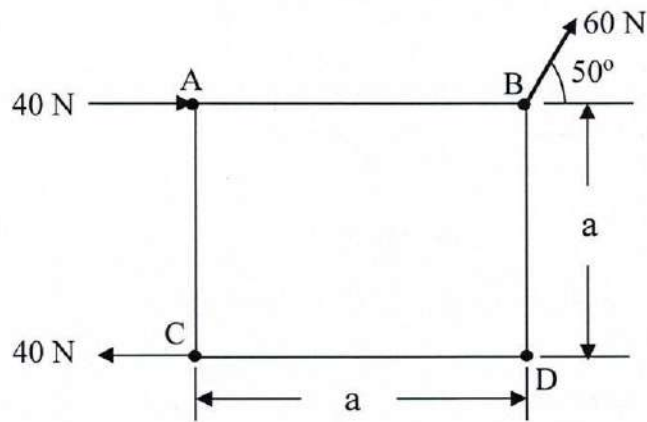
- 1(c) A uniform slender rod of length L and weight W is held in the position shown by the horizontal force P . Neglecting the effect of friction of A and B , determine the angle θ corresponding to equilibrium (i) in terms of P , W , L and β ; (ii) If $P = 75$ N, $W = 180$ N, $L = 700$ mm and $\beta = 55^\circ$. 13



- 2(a) Knowing that the tension in cable AB is 2450 N, determine (i) the angle formed by AB and a line joining points B and C; (ii) the projection on that line of the force exerted by cable AB at point B; (iii) the angle formed by AB and AC. 18

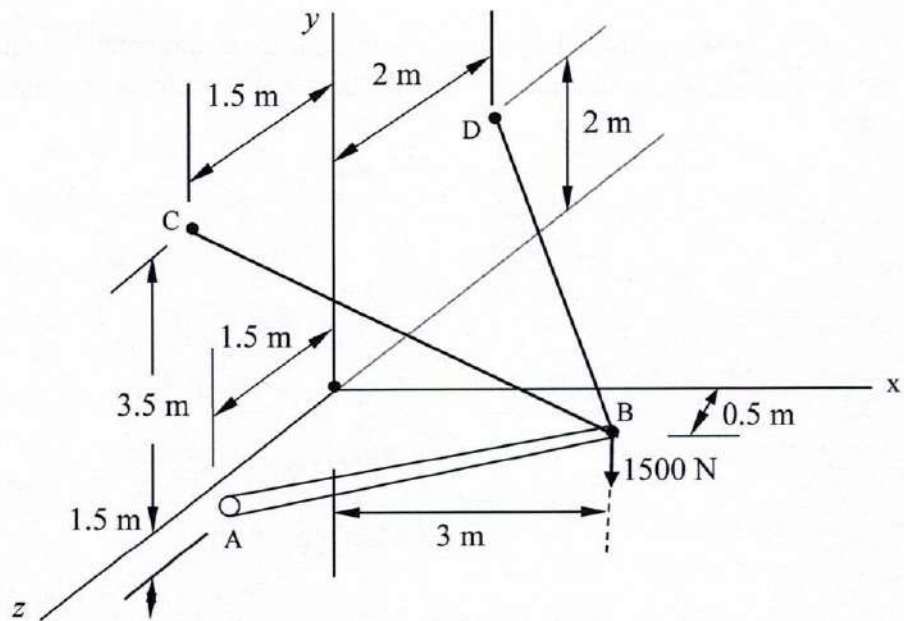


- 2(b) A force and a couple act as shown on a square plate of side $a = 50$ mm. Replace the given force and couple by a single force applied at a point located on (i) line AB and (ii) line CD. 17



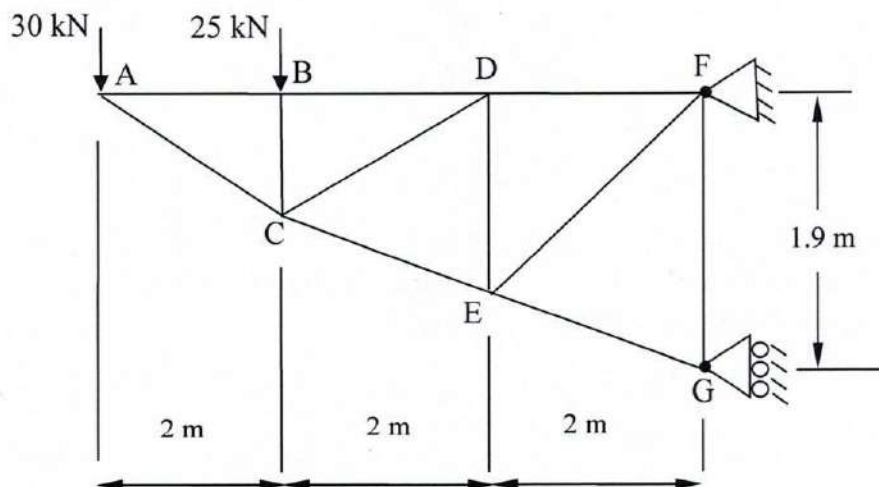
- 3(a) What is meant by equivalent couple? Explain with a schematic diagram. 07

- 3(b) The boom AB supports a load of 1500 N as shown. The boom is held by a ball and socket at A and by two cables BC and BD. The weight of the boom is 20 kg. Determine the tension in each cable and the reaction at A. 28

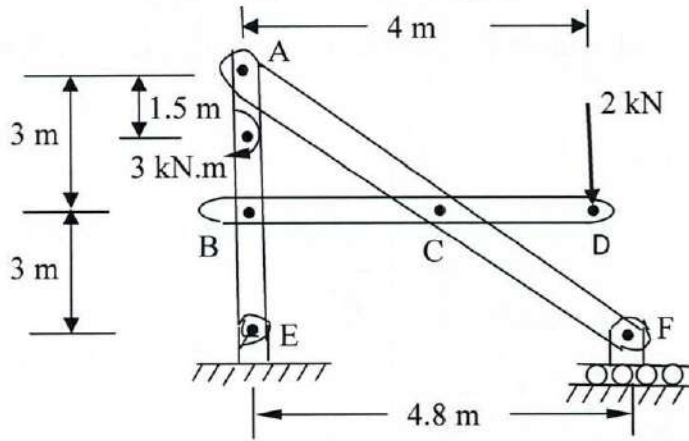


- 4(a) Define truss, frame and machine. Explain them with neat sketches. 06

- 4(b) Determine the forces in the members DF and DE of the truss shown in figure. 12

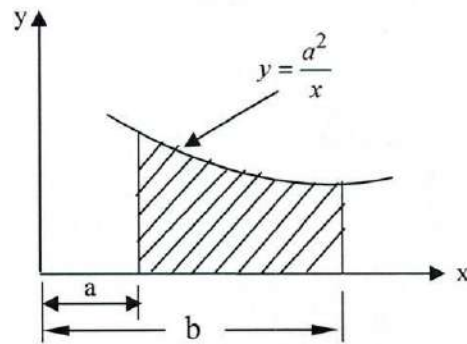


- 4(c) Draw the free body diagram of each link for the frame shown below and also calculate the external reactions and internal forces in each joints. 17

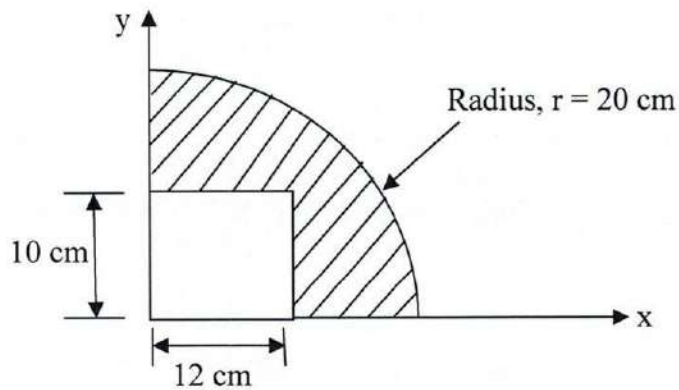


SECTION-B

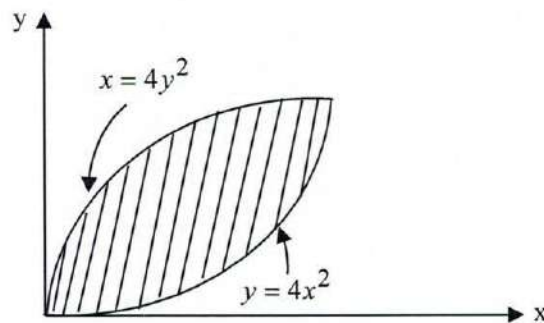
- 5(a) Knowing that $b = 3a$, determine the centroid of the area shown by direct integration method. 18



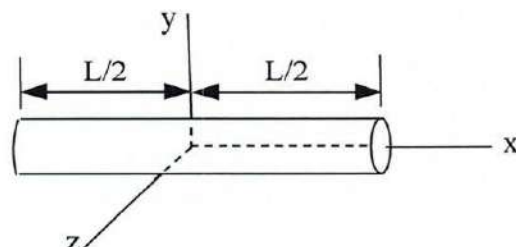
- 5(b) Calculate the centroid of the shaded area as shown in figure. 17



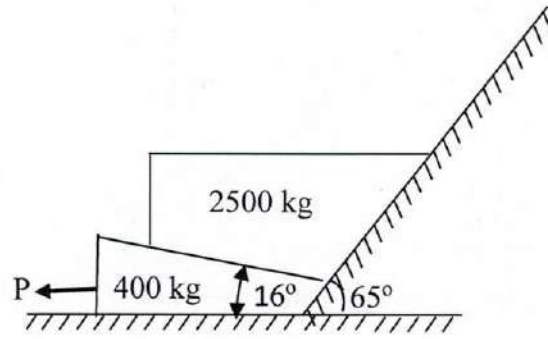
- 6(a) Determine the area moment of inertia I_x and I_y for the shaded area as shown in figure. 18



- 6(b) Determine the mass moment of inertia of the right circular cylinder of radius 'a' and length 'L' by direct integration method with respect to x and y axis. 17

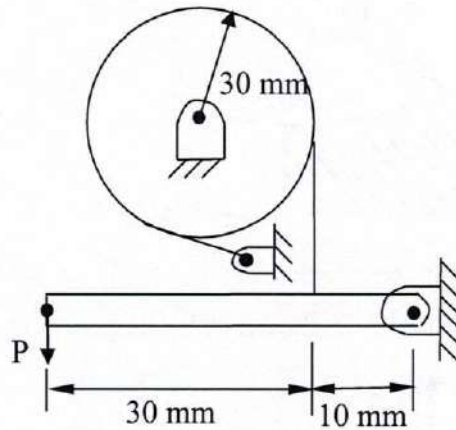


- 7(a) Determine the horizontal force P required to start the 400 kg wedge moving to the left. The angle of friction is 20° at all surfaces of contact. 18

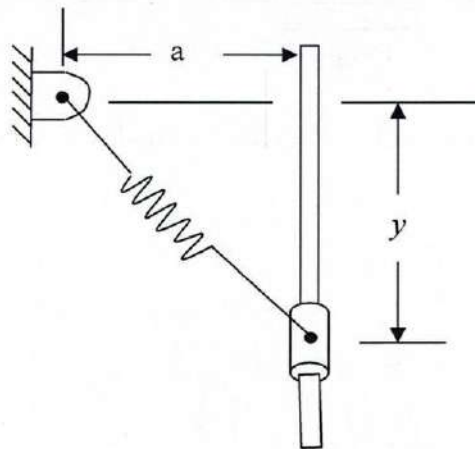


- 7(b) For a V-belt, prove that $T_1/T_2 = e^{(\mu\beta/\sin(\alpha/2))}$, where symbols have their usual meanings. 17

- 8(a) A band brake is needed to control the speed of a flywheel as shown. The coefficient of frictions are $\mu_s = 0.30$ and $\mu_k = 0.25$. What couple should be applied to the flywheel to keep it rotating counter clockwise at a constant speed when $P = 100$ N. 18



- 8(b) A collar B of weight W may move freely along the vertical rod shown. The constant of the spring is k and the spring is unstretched when $y = 0$. Determine the value of y corresponding to equilibrium when $W = 80$ N, $a = 300$ mm and $k = 500$ N/m. 17



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) Starting from Lorentz transformation show that $L = L_0 \sqrt{1 - \frac{v^2}{c^2}}$, where the symbols have their usual meanings. 10
- 1(b) What are the two postulates of special theory of relativity? Establish mathematically Einstein's mass-energy relationship. 15
- 1(c) A rocket ship is 100 m long on the ground. When it is in flight, its length is 99 m to an observer on the ground. What is its speed? 10
- 2(a) What is photoelectric effect? What are the limitations of classical electromagnetic theory to explain it. 12
- 2(b) Explain De Broglie's concept of matter waves. Find De Broglie wavelength of electron in the first orbit. 13
- 2(c) The photoelectric threshold frequency of silver is 1.086×10^{15} Hz. Calculate (i) the maximum kinetic energy of ejected electrons and (ii) the stopping potential in volts for the electrons, when the silver surface is illuminated with ultra-violet light of frequency 1.5×10^{15} Hz. 10
- 3(a) Show that the Quantum Physics give the same results as the Classical Physics in the limit of very large quantum numbers. 10
- 3(b) Discuss the spectral series of H₂-atom and calculate the limiting values of wavelength for different spectral series. 15
- 3(c) Using Bohr's formula calculate the largest wavelength in the Balmer series and between what wavelength limits does the Balmer series exist? 10
- 4(a) What is true mass defect? Discuss the significance of average binding energy. 10
- 4(b) What are the basic laws of radioactivity? Prove that $N = N_0 e^{-\lambda t}$ and hence show that $T_{1/2} = 0.693/\lambda$, where the symbols have their usual meanings. 15
- 4(c) The half life of 1 gm sample of ${}_{38}\text{Sr}^{90}$ against beta decay is 28 years. Calculate (i) the decay constant, (ii) rate of radioactive disintegration and (iii) mean life. 10

SECTION-B

- 5(a) What is meant by Miller indices of a plane? Discuss the procedure of finding Miller indices. 10
- 5(b) Discuss seven crystal systems by giving one example of each and describe the various types of Bravais lattices in case of three dimensions with the help of neat diagrams. 15
- 5(c) In a unit cell a simple cubic structure, find the angle between the normal to pair of planes whose Miller indices are (i) [111] & [110] and (ii) [211] & [312]. 10

- 6(a) Describe the formation of energy band in solids. Explain how it helps clarify the materials into metal, insulator and semiconductor. 10
- 6(b) Derive an expression for the lattice heat capacity of a solid following Einstein model. Discuss predictions of the model and compare it with experimental observations. 15
- 6(c) A copper wire of length 0.5 m long and diameter 0.3 mm has a resistance of 0.11Ω at 20°C . If the thermal conductivity of copper at 20°C is $390 \text{ Wm}^{-1}\text{K}^{-1}$, calculate Lorentz number. 10
- 7(a) What are static and transport properties in the case of free electron model? Show that the ratio between thermal and electrical conductivities is proportional to the temperature. 12
- 7(b) What is Hall effect? Deduce an expression for Hall coefficient for a metal and show the relation between Hall coefficient and Hall mobility. 15
- 7(c) Find the Hall coefficient and electron mobility of germanium if for a given sample (length 10 m, breadth 4 mm and thickness 1 mm) a current of 5 mA flown from a 1.6 volts supply develops a Hall voltage 20 mV across the specimen in a magnetic field of 0.45 wb/m^2 . 10
- 8(a) Give a brief outline of the form of input energy of a LASER. Discuss the characteristics of a LASER light. 12
- 8(b) Explain Lasing action. Describe the working principle of Ruby LASER with a suitable diagram. 13
- 8(c) The coherence length for the red Cadmium line of wavelength $6.55 \times 10^{-7} \text{ m}$ in 31 cm. Calculate (i) the number of oscillation corresponding to the coherence length and (ii) coherence time. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year Backlog Examination, 2022

Ch 1105

(Engineering Chemistry)

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) Explain electrophoresis, streaming potential and Dorn effect. 10
- 1(b) Describe the models of electrical double layer of colloidal particles at the interface. 10
- 1(c) Write down the differences between lyophobic and lyophilic colloid. 07
- 1(d) Write a short note on 'Coagulation'. 08
- 2(a) Discuss the factors that enhance the corrosion of building in Khulna region. 10
- 2(b) Discuss the electrochemical mechanism of corrosion with a suitable diagram. 10
- 2(c) Explain the effect of P^H and electrolytes on the rate of underwater corrosion. 10
- 2(d) Write a short note on 'Pitting corrosion'. 05
- 3(a) What are the major and minor raw materials usually used in manufacturing glass? 08
- 3(b) Describe the various steps of the fabrication of ceramic wares. 10
- 3(c) Define ceramics. Classify ceramics into different classes. Give a brief description of each class of ceramic products. 12
- 3(d) Write a short note on 'Cullet'. 05
- 4(a) Describe the defecation method for the clarification of extracted juice. 09
- 4(b) Write down the composition of different components in extracted juice. 08
- 4(c) Describe the manufacturing process of sugar from sugarcane with a flow diagram. 10
- 4(d) Explain the terms: 08
(i) Molasses (ii) Minglar syrup.

SECTION-B

- 5(a) Distinguish between homo-polymer and co-polymer. 09
- 5(b) What are the basic differences in polymer plastic and polymer fiber? Give examples of these two classes. 10
- 5(c) Distinguish between low density polyethylene (LDPE) and high density polyethylene (HDPE). 08
- 5(d) Write a short note on 'Oligomer'. 08

6(a)	Define natural rubber. Mention its important properties those have made it suitable for the manufacture of valuable goods.	13
6(b)	What is vulcanization? Why is it so important for natural rubber?	12
6(c)	Describe the manufacturing process of kraft pulp with a flow diagram.	10
7(a)	Classify raw materials of manufacturing Portland cement. Describe these raw materials in brief with suitable examples.	10
7(b)	What is retarder? Why is it essential ingredient of Portland cement? Give examples of some retarders.	10
7(c)	What is meant by calcareous and Argillaceous materials?	06
7(d)	What are the functions of C_3A , C_3S and gypsum in cement industries?	09
8(a)	What is fertilizer? Write down the characteristics of a good fertilizer.	10
8(b)	Describe the manufacturing process of urea from ammonia.	15
8(c)	What are nutrients? Why is organic fertilizer better than chemical fertilizer?	10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year Backlog Examination, 2022

Math 1105

(Mathematics I)

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 continuity of a function. Discuss the continuity and differentiability at $x = 0$ of the function: 15
- $$f(x) = \begin{cases} 1 & \text{when } x < 0 \\ 1 + \sin x & \text{when } 0 \leq x \leq \pi/2 \\ 2 + \left(x - \frac{\pi}{2}\right)^2 & \text{when } \pi/2 \leq x \end{cases}$$
- 1(b) Find $\frac{dy}{dx}$, where $y = x \cos^{-1} x + (\sin x)^{\ln x}$. 10
- 1(c) Find a and b such that $\lim_{x \rightarrow 0} \frac{x(1+a \cos x) - b \sin x}{x^3} = 1$ exists. Find also the value of limit. 10
- 2(a) State Leibnitz's theorem. If $y = e^{\cos^{-1} x}$, then find the relation connecting y_n , y_{n+1} and y_{n+2} . 12
- 2(b) State Rolle's theorem. Verify the Rolle's theorem for the function $f(x) = x^2 - 5x + 6$ in the interval $[2,3]$. 12
- 2(c) Examine the validity of Lagrange's mean value theorem for the function $f(x) = \frac{1}{x}$ in the interval $[-1,1]$. 11
- 3(a) Expand $\cos^2 x$ in powers of $(x - \pi/4)$ in a finite Taylor's series with the remainder in Lagrange's form. 12
- 3(b) Discuss the maxima and minima of $y = 2x^3 - 21x^2 + 36x - 20$. 12
- 3(c) If $u = f(x^2 + 2yz, y^2 + 2zx)$, then show that $(y^2 - zx) \frac{\partial u}{\partial x} + (x^2 - yz) \frac{\partial u}{\partial y} + (z^2 - xy) \frac{\partial u}{\partial z} = 0$. 11
- 4(a) Determine the equation of tangent and normal to the curve $xy^2 = 4(4 - x)$ at the point where it is cut by the line $y = x$. 11
- 4(b) Define radius of curvature. Find the radius of curvature of the parabola $x^2 = 4ay$ at $(2a, a)$. 11
- 4(c) Find all possible asymptotes of the curve $x^2y^2 - 3x^2y - 3xy^2 + 2x^2 - 4y^2 - 3x - 4y = 0$. 13

SECTION – B

- 5(a) Integrate $\int \frac{x^2-x+1}{x^2+x+1} dx$. 11
- 5(b) Integrate $\int \frac{x^2}{x^4+x^2+1} dx$. 12
- 5(c) Integrate $\int \frac{1-\sin x-\cos x}{1+\sin x-\cos x} dx$. 12
- 6(a) Evaluate $\int_{\alpha}^{\beta} \frac{dx}{x\sqrt{(x-\alpha)(\beta-x)}}$. 12
- 6(b) Evaluate $\int_0^{\pi} \frac{x \tan x}{\sec x + \tan x} dx$. 12
- 6(c) Evaluate $\int_0^1 x \sin^{-1} x dx$. 11
- 7(a) Find the reduction formula of $I_{m,n} = \int_0^{\pi/2} \cos^m x \cos nx dx$ and hence evaluate $I_{6,5}$. 15
- 7(b) Evaluate $\lim_{n \rightarrow \infty} \left[\frac{1}{na} + \frac{1}{na+1} + \frac{1}{na+2} + \frac{1}{nb} \right]$. 08
- 7(c) Derive the Legendre duplication formula $2^{2m-1} \Gamma(m) \Gamma(m + \frac{1}{2}) = \Gamma(2m) \sqrt{\pi}$. 12
- 8(a) Use the rule of differentiation under integral sign to prove that $\int_0^{\infty} \frac{\ln(1+a^2x^2)}{1+b^2x^2} dx = \frac{\pi}{b} \ln \frac{a+b}{b}$. 12
- 8(b) Find the area bounded by the asteroid $x^{2/3} + y^{2/3} = a^{2/3}$. 11
- 8(c) Find the volume of the solid generated by the revolving about the x-axis of a loop of the curve $(x - 4a)y^2 = ax(x - 3a)$. 12

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year Backlog Examination, 2022

Math 1205
(Mathematics II)

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 direction cosines and direction ratios of a line. Prove that the sum of the square of direction cosines of a line is unity. 12
- 1(b) Find the cylindrical and spherical polar coordinates of a point whose Cartesian coordinate is (2,-1,3). 10
- 1(c) If two lines whose direction cosines are connected by the two relations $al + bm + cn = 0$ and $ul^2 + vm^2 + wn^2 = 0$, find the condition that they are parallel. 13
- 2(a) Find the equation of the plane through (0,-3,1) and (6,-5,1), and which cuts off from the axes intercepts whose sum is zero. 12
- 2(b) A variable plane at a constant distance P from the origin meets the axes in A, B and C. Through A, B, C, planes are drawn parallel to the coordinate planes. Show that the locus of their points of intersection is $x^{-2} + y^{-2} + z^{-2} = P^{-2}$. 12
- 2(c) Find the distance of the point (-1, -5, -10) from the point where the line $\frac{1}{3}(x-2) = \frac{1}{4}(y+1) = \frac{1}{12}(z-2)$ meets the plane $x-y+z=5$. 11
- 3(a) Find the length and equation of the shortest distance between the lines $\frac{x-1}{2} = \frac{y}{1} = \frac{z+3}{4}$ and $\frac{x+1}{3} = \frac{y-1}{4} = \frac{z}{2}$. 12
- 3(b) Find the equation of the sphere through the circle $x^2 + y^2 + z^2 = 1$, $2x + 3y + 6z = 6$ and touching the plane $x=0$. 11
- 3(c) Find the center and radius of the circle in which the sphere $x^2 + y^2 + z^2 + 2y + 4z - 11 = 0$ is cut by the plane $x + 2y + 2z + 15 = 0$. 12
- 4(a) Find the equation of the cone whose vertex is the point (1,1,0) and whose guiding curve is $x^2 + y^2 = 4$, $y = 0$. 13
- 4(b) Obtain the equation of the right circular cone with vertex at (1,-2,-1), semi vertical angle 60° , and the axis $\frac{x-1}{3} = \frac{y+2}{-4} = \frac{z+1}{5}$. 13
- 4(c) Find the condition that the line $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z}{4}$ lie on a plane, $3x + 2y - z = 10$. 09

SECTION-B

- 5(a) Define order and degree of a differential equation. Obtain the differential equation associated with the primitive $y = a + b(\log x) + c(\log x)^2 + x^2$, where a, b, and c are arbitrary constants. 13
- 5(b) Show that the differential equation $2ye^{x/y}dx + (y - 2xe^{x/y})dy = 0$ is homogeneous and find its particular solution, given that $x = 0$ when $y = 1$. 11
- 5(c) Solve the differential equation $(2xy^4e^y + 2xy^3 + y)dx + (x^2y^4e^y - x^2y^2 - 3x)dy = 0$ using integrating factor. 11
- 6(a) Solve the initial value problem $x \frac{dy}{dx} + y = (xy)^{3/2}$, $y(1) = 4$. 09
- 6(b) Solve the initial value problem $\cos xy' + y \sin x = 2 \cos^3 x \sin x - 1$, $y(\pi/4) = 3\sqrt{2}$, $0 \leq x \leq \pi/2$. 12
- 6(c) A body of temperature 80°F is placed at time $t = 0$ in a medium which is maintained at 50°F . At the end of 5 minutes, the body was cooled to a temperature of 70°F . What will be the temperature of the body at the end of 10 minutes? When will the temperature of the body be 60°F ? 14
- 7(a) Find the general solution of $(D^2 + D + 1)^2 (D^2 - 4)^2 y = 0$; $D = \frac{d}{dx}$. 10
- 7(b) Solve the initial value problem $(D^2 - 2D + 1)y = 2xe^{2x} + 6e^x$, $y(0) = 1$, $y'(0) = 0$ using the undetermined coefficient method. 13
- 7(c) Find the general solution of $\frac{d^2y}{dx^2} + 4y = 4 \tan 2x$ by the method of variation of parameters. 12
- 8(a) Solve the differential equation $(D^2 - 2D + 1)y = x^2e^{3x}$, where $D = \frac{d}{dx}$. 11
- 8(b) Solve $\frac{d^2y}{dx^2} - 4 \frac{dy}{dx} + 6y = e^{2x}$, where $y = 0$ and $\frac{dy}{dx} = 1$, for $x = 0$. 11
- 8(c) Find the general solution of the differential equation $(3x + 2)^2 \frac{d^2y}{dx^2} + 3(3x + 2) \frac{dy}{dx} - 36y = 3x^2 + 4x + 1$. 13

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year Backlog Examination, 2022

ME 1105

(Thermal Engineering)

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) What are the available sources of energy in Bangladesh? Describe the present energy situation in Bangladesh. 12
- 1(b) Explain the present power generation and future prospect from coal energy in Bangladesh. 08
- 1(c) What is meant by fossil fuel? Briefly explain the sources of fossil fuels and describe the impacts of fossil fuel on the environment. 15
- 2(a) Define the terms: (i) Dryness fraction, (ii) Enthalpy of steam and (iii) Entropy of steam. 06
- 2(b) What is meant by pure substance? Draw the P-v-T surface diagram for a substance which extract upon freezing. 07
- 2(c) Derive an expression for the external work done during evaporation of different conditions of steam. 07
- 2(d) Calculate the internal energy per kg of superheated steam at a pressure of 12 bar and a temperature of 325°C. If this steam is expanded to 1.8 bar and dryness fraction 0.90, determine the change in internal energy. Assume specific heat of superheated steam is 2.15 kJ/kg.K. 15
- 3(a) What is meant by steam generator? What factors should be considered while selecting a steam generator? 08
- 3(b) Compare between the water tube and fire tube boiler. 07
- 3(c) Describe the working principle of Babcock and Wilcox boiler with the help of a schematic diagram. 12
- 3(d) Why safety valves are needed in a boiler? Explain the functions of blow off cock and fusible plug. 08
- 4(a) What are the differences between boiler mountings and accessories? Draw a simple schematic diagram of a boiler plant. 07
- 4(b) What are priming and foaming of a boiler? How do priming and foaming occur? 06
- 4(c) What is meant by boiler trial? Mention the different types of heat losses occurred in a boiler. 07
- 4(d) A boiler plant consists of an economiser, a boiler and a superheater. Feed water leaves the economiser at 85°C and leave the boiler drum with 95% quality at 15 bar. The same gets superheated to 250°C in the superheater. If the feed water of 34°C supplied to the economiser at the rate of 10 kg of coal fired, calculate-
- (i) The efficiency of the plant assuming calorific value of coal is 32.6×10^3 kJ/kg, and (ii) the percentage of total heat absorbed by the economiser, boiler and superheater.

SECTION-B

- 5(a) What is meant by the term 'fuel'? What are the advantages of gaseous fuel over solid and liquid fuels? 08
- 5(b) What are meant by the term 'stoichiometric air' and 'excess air'? Write down the combustion equation when hexane is combusted with 35% of excess air. 12
- 5(c) Calculate the stoichiometric air-fuel ratio for the combustion of a sample of dry coal of the following mass: 15
C = 84%, H₂ = 5%, O₂ = 2.5%, S = 0.5% and rest is ash.
Also determine the volumetric composition of the dry products of combustion if 24% excess air is supplied. Assume that air contains 23.5% O₂ and rest are N₂ by mass.
- 6(a) What is meant by heat engine? How would IC engine be classified? 08
- 6(b) Draw and explain the actual indicator diagram of a four stroke cycle diesel engine. 08
- 6(c) What is detonation in IC engines? What are the factors which causes detonation? 07
- 6(d) Describe the working principle of a closed cycle gas turbine with schematic arrangement and P-V, T-S diagram. 12
- 7(a) Describe the methods commonly used to improve the thermal efficiency of a gas turbine. 10
- 7(b) Define the terms: (i) Tonne of refrigeration, (ii) coefficient of performance, and (iii) Heat pump. 06
- 7(c) Prove that $(COP)_H = 1 + (COP)_R$, where the symbols have their usual meanings. 06
- 7(d) Describe the working principle of a vapor compression refrigeration system with a neat sketch. 13
- 8(a) Define the following terms: 08
(i) Saturated air, (ii) Relative humidity, (iii) Dew point temperature (iv) Sensible heat factor.
- 8(b) What is meant by human comfort? Describe the factors which affect comfort air conditioning. 07
- 8(c) Describe the working principle of a summer air conditioning system with a neat sketch. 10
- 8(d) Atmospheric air at 1 atm pressure has 30°C dry bulb temperature and 21°C wet bulb temperature. By using psychrometric chart, determine (i) relative humidity, (ii) dew point temperature, and (iii) change of enthalpy. 10