

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B.Sc. Engineering 1st Year 2nd Term Examination, 2021

Ph 1205
(Physics)

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) Show that the velocity of light is constant for all observers regardless of their motion. 10
- 1(b) What are the two postulates of the special theory of relativity? Derive the Lorentz transformation equations. 15
- 1(c) A woman leaves the earth in a spacecraft that makes a round trip to the nearest star 4.2 light-year distance at a speed of $0.9992c$. Upon her return how many days younger is her twin sister who remained behind? 10
- 2(a) Discuss the Einstein's hypothesis about photoelectric effect. 10
- 2(b) Derive an expression for Compton shift, $\Delta\lambda = \frac{h}{m_0c}(1 - \cos\phi)$, where the symbols have their usual meaning. 15
- 2(c) The photo-electric threshold wavelength of silver is 2762 \AA . Calculate the maximum velocity of the electrons and the stopping potential in volts for the electrons, when the surface is illuminated with ultraviolet light of wavelength 2000 \AA . 10
- 3(a) Show that quantum physics gives the same result as classical physics in the limit of very large quantum numbers. 10
- 3(b) According to Bohr's atom model, derive an expression for the energy of an electron in the n-th orbit. 15
- 3(c) Calculate the limiting values of Balmer and Pfund series. 10
- 4(a) Explain controlled and uncontrolled chain reactions. 10
- 4(b) State radioactive decay laws. Derive expressions for secular and permanent equilibrium. 15
- 4(c) The half life of ${}_{92}\text{U}^{238}$ is 4.5×10^9 years. What percentage of ${}_{92}\text{U}^{238}$ that existed 10^{10} years ago still survives? What is the average life of ${}_{92}\text{U}^{238}$? 10

SECTION – B

- 5(a) Write down the Bravais lattices and unit cell specifications of seven crystal systems. 10
- 5(b) What is atomic packing fraction? Calculate atomic packing fraction for simple, face centered and body centered cubic structures. 15
- 5(c) A diffraction pattern is obtained for lead with radiations of wavelength 1.54 \AA . The (220) reflection is observed at Bragg angle, 32° . What is the lattice parameter of lead and the radius of the atom? (Lead has fcc structure). 10

- 6(a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. 10
- 6(b) According to Einstein's model, the average energy of an oscillator is $\bar{\epsilon} = \frac{1}{2} h\nu + \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1}$. Now obtain an expression for lattice heat capacity for a crystal of N number of atoms. Discuss the validity of this model at low and high temperatures. 15
- 6(c) The Debye temperature for diamond is 2230 K. Calculate the highest possible lattice vibration frequency, ν_D and the molar heat capacity of diamond at 10 K. 10
- 7(a) What is Hall effect? Derive an expression for Hall voltage and show that Hall coefficient $R_H = \frac{1}{ne}$. 10
- 7(b) According to Sommerfeld theory, obtain an expression for normalized wave function, $\psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L} x\right)$, where the symbols have their usual meaning. 15
- 7(c) Copper has a mass density of $8.9 \times 10^3 \text{ kgm}^{-3}$ and an electrical conductivity 6.5×10^7 mho/meter at room temperature. Calculate (i) mean free time, (ii) Fermi energy and (iii) Fermi velocity. 10
- 8(a) Explain population inversion and stimulated emission. 10
- 8(b) Discuss briefly the construction and working principle of Helium-Neon gas laser. 15
- 8(c) A laser beam has a power of 50 mW. It has an aperture of 5×10^{-3} m and it emits light of wavelength 7200 Å. The beam is focused with a lens of focal length 0.1 m. Calculate the area and the intensity of the image. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B.Sc. Engineering 1st Year 2nd Term Examination, 2021

Hum 1205

(Economics and Accounting)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if any missing.

SECTION – A

- 1(a) Define Economics. Distinguish between Microeconomics and Macroeconomics. 10
- 1(b) Explain the fundamental problems of an economic system. 10
- 1(c) How the following terms affect the demand (i) Taste and preference, (ii) Income of the consumers and (iii) Size and composition of the population. 15
- 2(a) Define price elasticity. 05
- 2(b) State the measuring methods of price elasticity of demand with formula and example. 20
- 2(c) What are the internal & external economies and diseconomies of production? Explain with example. 10
- 3(a) What are Gross Domestic Product (GDP), Real GDP and GDP growth? 10
- 3(b) What are the methods of calculating GDP? Explain each method with cautions. 12
- 3(c) Explain briefly Private Savings, Public Savings and National Savings. 13
- 4(a) What are the causes of inflation? Graphically explain. 15
- 4(b) Assume ABC company is going to invest Tk. 10,000. The company considering two projects, namely project X and project Y and wants to decide whether to invest or not. Both projects are four-year projects and the cash flow of both the project for four years are given below: 20

Year	Project A Cash Flows	Project B Cash Flows
1	Tk. 5,000	Tk. 1,000
2	Tk. 4,000	Tk. 3,000
3	Tk. 3,000	Tk. 4,000
4	Tk. 1,000	Tk. 6,750

Comment as per your analysis.

SECTION – B

- 5(a) Define accounting. As an engineer, how can you use your accounting knowledge in your professional life? 15
- 5(b) What is meant by business transactions? State the features of business transactions and give some examples. 20

- 6(a) Elaborately explain the principles of GAAP. 10
- 6(b) The transactions for Raha's animal care are as follows during the month of March 01, 2022. 25

- March, 01 Paid monthly rent of Tk. 1,200
 03 Performed services for Tk. 160 on account
 05 Performed services for cash of Tk. 75
 08 Purchased equipment for Tk. 600. The company paid cash of Tk. 90 and the balance was on account
 12 Received cash from customers billed on March 03
 14 Paid salaries and wages to employees of Tk. 525
 22 Paid utilities of Tk. 72
 24 Borrowed Tk. 1,500 from NCC Bank by using a note
 27 Paid Tk. 220 to repair services for plumbing repairs
 28 Paid balance amount owed from equipment purchase on March 08
 30 Paid Tk. 1,800 for six months of insurance

Instructions: Journalize the transactions.

- 7(a) Define cost. Classify cost in relation to the accounting period. 10
- 7(b) Various cost and sales data for Aryan company for the just completed year appear in the worksheet below: 25

Sales	Tk. 7,00,000
Depreciation, factory	30,000
Advertising expenses	75,000
Electricity bill, factory	11,000
Maintenance, factory	45,000
Rent, factory	15,000
Insurance, factory	2,000
Purchase of raw materials	1,30,000
Raw materials inventory, beginning	9,000
Raw materials inventory, ending	6,000
Direct labor	70,000
Indirect labor	15,000
Work in process inventory, beginning	17,000
Work in process inventory, ending	30,000

Requirement: Prepare a schedule of the cost of goods manufactured.

- 8(a) What are the techniques used for the interpretation of financial statements? 05
- 8(b) Aristocrat Restaurant opened for business on May 31, 2021. Its trial balance before adjustment on May 31 is as follows: 30

	Debit (Tk.)		Credit (Tk.)
Cash	3,400		4,700
Supplies	2,080	Accounts payable	3,300
Prepaid insurance	2,400	Unearned rent revenue	40,000
Land	12,000	Mortgage payable	41,000
Buildings	60,000	Sales revenue	10,300
Equipment	15,000	Service revenue	380
Advertising expense	600		
Salaries and wages expense	3,300		
Utility expense	900		
Total	99,680		99,680

Analysis reveals the following additional data:

- (i) Prepaid insurance is a 1-year policy starting May 1, 2021.
- (ii) A count of supplies shows Tk. 750 of unused supplies on May 31.
- (iii) Annual depreciation is Tk. 3,600 on buildings and Tk. 1,500 on equipment.
- (iv) The mortgage interest rate is 6% (The mortgage was taken out on May 1).
- (v) Two-thirds of unearned rent revenue has been earned.
- (vi) Salaries of Tk. 750 are acquired and unpaid on May 31.

Instructions:

- (i) Prepare an adjusted trial balance on May 31.
- (ii) Prepare an income statement and balance sheet on May 31.

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Department of Mechanical Engineering

B.Sc. Engineering 1st Year 2nd Term Examination, 2021

Math 1205
(Mathematics II)

Time: 3 Hours

Total Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.
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SECTION – A

- 1(a) Find the cylindrical and spherical polar coordinates of a point whose rectangular Cartesian coordinates are $(-2, 2\sqrt{3}, -4\sqrt{3})$. 10
- 1(b) Define direction cosine and direction ratio of a line. If a line makes angles α, β, γ with the axes prove that $\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$. 12
- 1(c) Show that the straight line where direction cosines are given by the relation $al + bm + cn = 0$ and $fmn + gnl + hln = 0$ are perpendicular if $f/a + g/b + h/c = 0$. 13
- 2(a) Find the equation of the planes through $(0, 4, -3)$ and $(6, -4, 3)$ and which cuts off from the axes intercepts whose sum is zero. 13
- 2(b) To find the condition that the line $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ may lie on a plane $ax + by + cz + d = 0$. 10
- 2(c) Obtain the equation of the plane perpendicular to each of the planes $x - 4y + z = 0$ and $3x + 4y + z = 2$ and is at a constant distance unity from the origin. 12
- 3(a) Find the distance of the point $(2, -4, 5)$ from the plane $2x + 5y + 6z - 11 = 0$ measured parallel to the line $\frac{x}{2} = \frac{y}{1} = \frac{z}{-2}$. 10
- 3(b) Find the length and the equation of the line of the shortest distance between the lines $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$. 15
- 3(c) Find the equation of the sphere with its center $(-4, 2, 3)$ and tangent to the plane $2x - 3y + 5z = 10$. 10
- 4(a) Define great circle. Find the equation of the sphere in which the circle $x^2 + y^2 + z^2 + 10y - 4z - 8 = 0, x + y + z - 3 = 0$ is a great circle. 12
- 4(b) What is the right circular cone? Find the equation of the right circular cone whose vertex is at the origin and axis the z-axis, semi-vertical angle β . 13
- 4(c) Show that the equation of the cone which vertex is at origin is homogenous in x, y, z . 10

SECTION – B

- 5(a) What is the degree and order of a differential equation? Find the differential equation of all circles passing through the origin and having their center on the x-axis. 13
- 5(b) Define homogeneous differential equation and solve $(3y - 7x + 7)dx - (3x - 7y - 3)dy = 0$. 10
- 5(c) Define exact differential equation. Determine the value of k so that the equation $(y^2e^xy^2 + 4x^3)dx + (2xye^{xy^2} + ky^2)dy = 0$ is exact. Hence find the general solution of the given differential equation. 12
- 6(a) What is the integrating factor of a differential equation? Find the integrating factor and solution of the differential equation $(x^2 + y^2 + x)dx + xydy = 0$. 12
- 6(b) Solve the differential equation $xdy - \{y + xy^3(1 + \ln x)\}dx = 0$. 10
- 6(c) A tank initially contains 35 gallons of fresh water. Brine, containing 3 pounds of water, flows into the tank at the rate of 3.5 gallons per minute, and the mixture is kept uniform stirring, and runs out at the same rate. How long time will it take to increase the quantity of salt in the tank from 35 to 55 pounds? 13
- 7(a) Solve the differential equation $(D^3 - D^2 + 3D + 5)y = x^2 + e^x \cos 2x$ using the undetermined coefficient method. 13
- 7(b) Solve: $(D^2 - 4D - 4)y = 8(x^2 + e^{2x} + \sin 2x)$. 10
- 7(c) If $(D + b)^4y = \cos ax$, then show that the complete solution is $y = (c_1 + c_2x + c_3x^2 + c_4x^3)e^{-bx} + \frac{\cos[bx - 4\tan^{-1}(\frac{b}{a})]}{(a^2 + b^2)^2}$. 12
- 8(a) Solve $\frac{d^2y}{dx^2} = y + \frac{2}{1+e^x}$ by the method of variation of parameter. 13
- 8(b) Solve: $(x^2D^2 - xD + 4)y = \cos(\log x) + x\sin(\log x)$. 12
- 8(c) Solve: $(D^2 + 8D + 16)y = xe^{-4x} \cos x$. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B.Sc. Engineering 1st Year 2nd Term Examination, 2021

ME 1209

(Engineering Mechanics I)

Time: 3 Hours

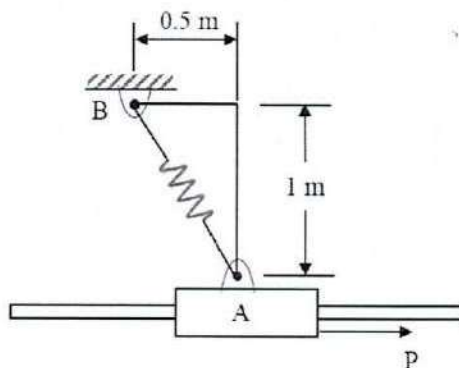
Total Marks: 210

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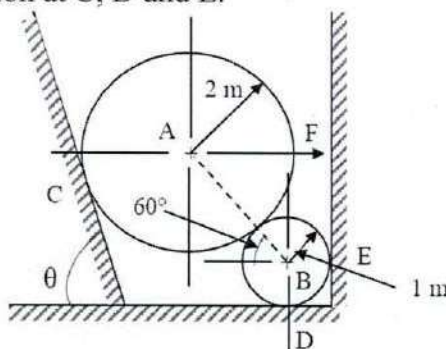
SECTION – A

1(a) Explain concurrent forces and coplanar forces. 05

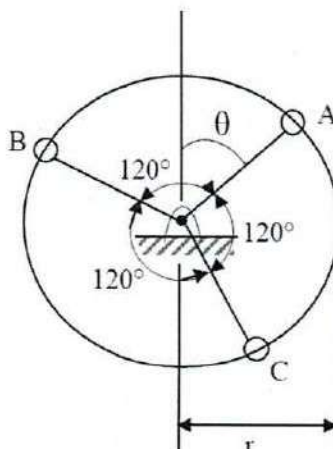
1(b) The collar A may slide freely on the horizontal frictionless rod. The spring attached to the collar has a constant of 1000 N/m and is undeformed when the collar is directly below support B. Determine the magnitude of the force P required to maintain equilibrium. 15



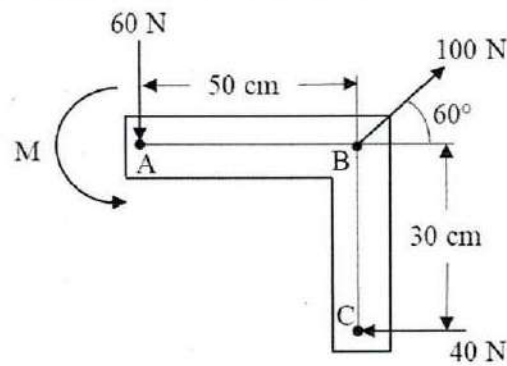
1(c) Two spheres are at rest against smooth surfaces as shown in figure. Sphere A weighs 1250 kg and sphere B weighs 165 kg. Let the horizontal force F is 4100 N and $\theta = 65^\circ$. Find the reaction at C, D and E. 15



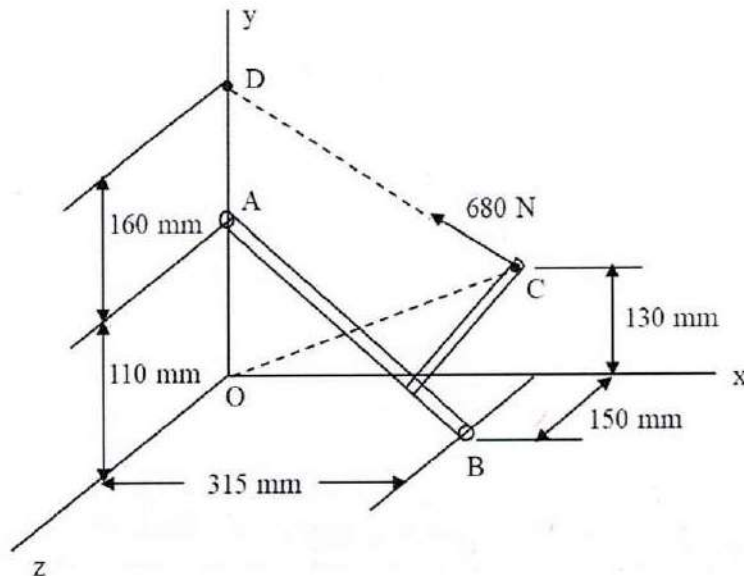
2(a) Three weights A = 2.5 kg, B = 5 kg, C = 7.5 kg are attached to the rim of a uniform wheel at a 60 cm radius and spaced 120° apart. If the wheel is free to rotate about its axis, what angle θ will the radius to point A make with the vertical when the wheel is at stable position? 18



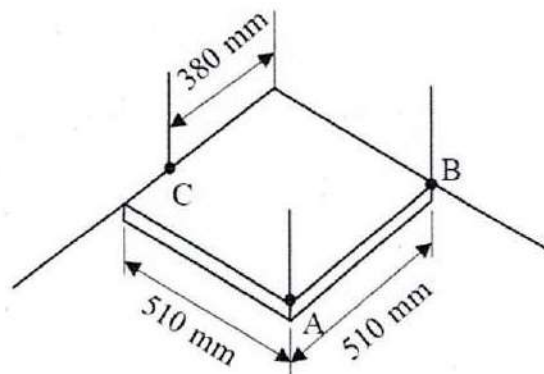
- 2(b) The three forces shown and a couple of magnitude $M = 100 \text{ N}\cdot\text{m}$ are applied to the angle bracket. (i) Find the resultant of this system of forces (ii) Locate the points where the line of action of the resultant intersects line AB and line BC. 17



- 3(a) Two rods are welded together to form a T-shaped lever which is acted upon by a 680 N force as shown. Determine the moment of the force about rod AB. 18

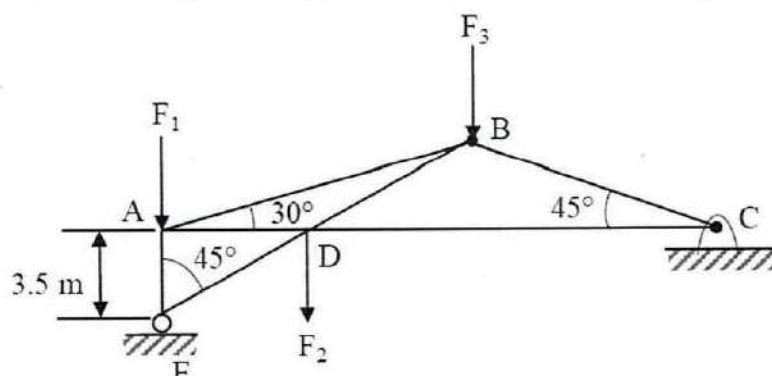


- 3(b) The 30 kg square plate shown is supported by three wires. Determine the tension in each wire. 17

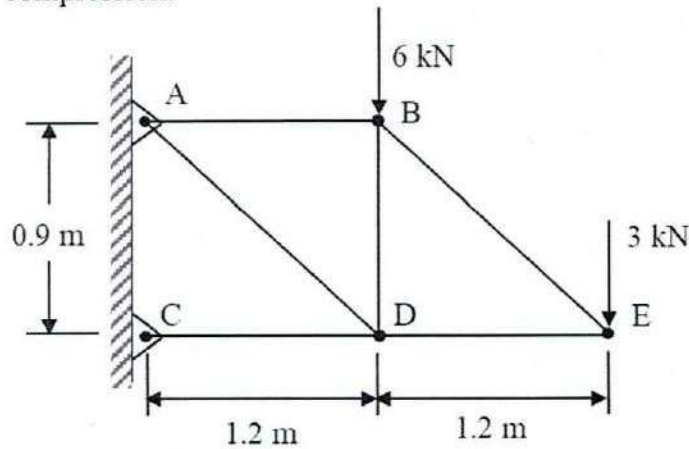


- 4(a) Distinguish between truss, frame and machine. 05

- 4(b) The framework in figure is loaded with forces $F_1 = F_2 = F_3 = 3100 \text{ N}$ as shown. Find the loads on each member (In the solution section the members AB, AD and DE). 15

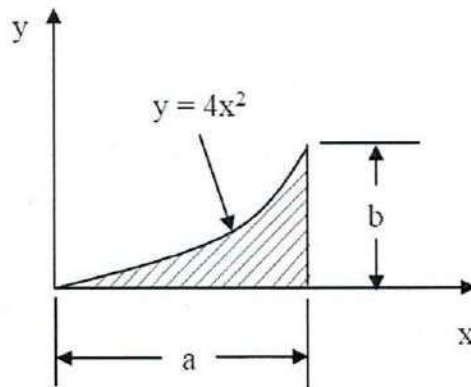


- 4(c) Determine the forces in each member of the truss shown. State whether each member is in tension or compression. 15

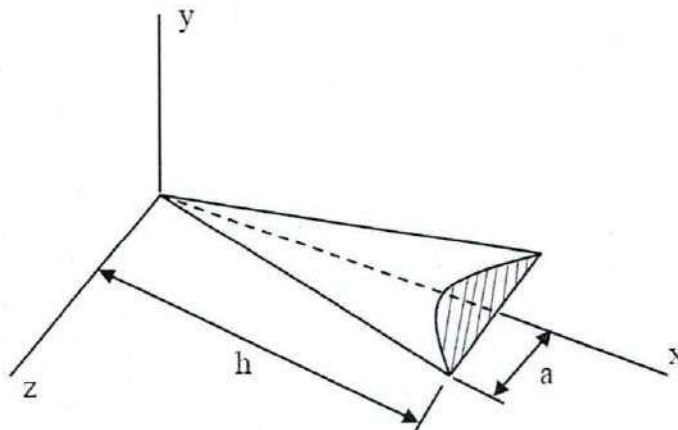


SECTION - B

- 5(a) Determine the \bar{x} and \bar{y} of the shaded area by direct integration and also determine the volume generated by rotating it about x axis. 18

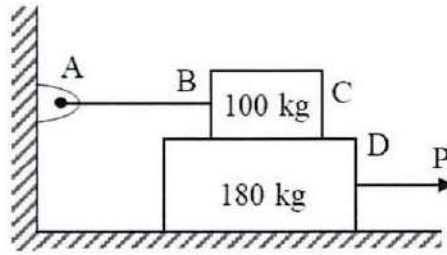


- 5(b) Determine the location of the centroid of the half circular cone as shown below. 17

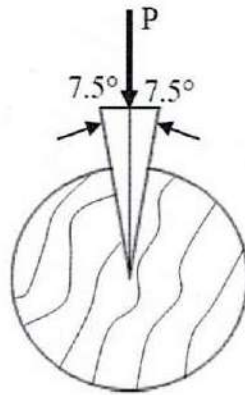


- 6(a) An effort of 1500 N is required to move a certain body of weight W up an inclined plane of angle 12° , force acting parallel to the plane. If the angle of inclination is increased to 15° then the effort required is 1750 N. Find the weight of the body and the coefficient of friction. 15
- 6(b) The mean diameter of a square threaded jack is 50 mm. The pitch of the thread is 10 mm. The coefficient of friction is 0.15. What force must be applied at the end of 0.7 m long lever, which is perpendicular to the longitudinal axis of the screw to raise a load of 20 kN and lower it? 15
- 6(c) Explain why rolling a roller is easier than pulling a roller. 05

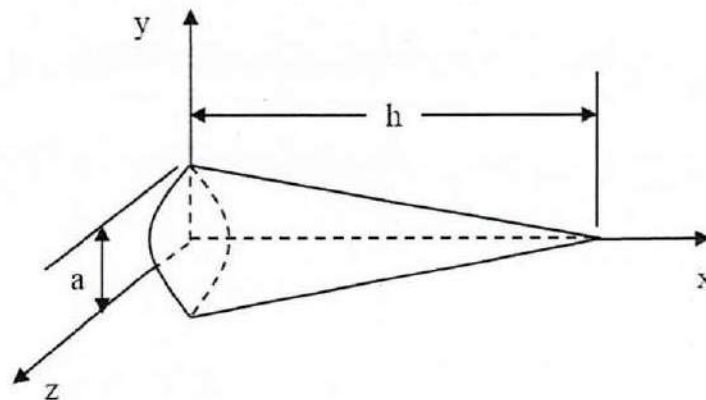
- 7(a) The coefficient of friction are $\mu_s = 0.30$ and $\mu_k = 0.25$ between all surfaces of contact. Knowing that $P = 950$ N, determine (i) the resultant of the friction forces exerted on the block D if block C is restrained as shown, and (ii) the friction force exerted by the ground on block D if cable AB is cut. 18.



- 7(b) A 15° wedge is used to split a log. The coefficient of friction between all surfaces is 0.35. Knowing that a force P of magnitude 3.2 kN was required to insert the wedge, determine the magnitude of the forces exerted on the log by the wedge after it has been inserted. 17



- 8(a) Determine by direct integration the mass moment of inertia with respect to y -axis of the right circular cone as shown in figure assuming uniform density and a mass m . 18



- 8(b) A thin plate of mass 'm' is cut in the shape of an isosceles triangle of width 'b' and height 'h'. Determine the mass moment of inertia of the plate with respect to (i) the centroidal axes AA' and BB' in the plane of the plate, (ii) the centroidal axis CC' perpendicular to the plate. 17

