BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2018-2019

Sub : **CE 101** (Analytical Mechanics)

Full Marks: 210   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Calculate the support reactions of the beam shown in Fig.1.   **(10)**

    (b) For the truss shown in Fig. 2, find the force in the members bi, cd, dg and gf.   **(15)**

    (c) The tower shown in Fig. 3 is held in place by three cables. If the force of each cable acting on the tower is as shown in the figure, determine the magnitude and direction of the resultant force. Take x = 20 m and y = 15 m.   **(10)**

2. (a) Determine the force P needed to hold the 100 lb block in equilibrium as shown in Fig. 4.   **(7)**

    (b) A wedge B is inserted between a fixed surface A and a movable block C which weighs 5000 lb as shown in Fig. 5. For all slipping surface f = 1/3. If there is a horizontal resistance acting on C of R = 8000 lb, what force Q will impose impending motion of C?   **(12)**

    (c) Determine the forces in all two-force members and horizontal and vertical components of the reactions at A and B of the frame shown in Fig. 6. Let, F_1 = 5000 lb, and F_2 = 4000 lb.   **(16)**

3. (a) Determine the location of centroid of the area bounded by the curves y^2 = 16x and y = x.   **(15)**

    (b) What is the least radius of gyration of the shaded area of Fig. 7.   **(20)**

4. (a) Find the centroid of a right circular cone whose altitude is h and base has a radius r.   **(10)**

    (b) Derive the expression of moment of inertia of a thin homogeneous disk about a diametral axis through its centroid.   **(10)**

    (c) The wood handle, of the mallet of Fig. 8, is L = 3 ft long, weighs 3.14 lb and has uniform cross section. The head weighing 16.1 lb, is a wood cylinder of diameter D = 6 in. Find the moment of inertia of mass of the mallet with respect to y axis.   **(15)**
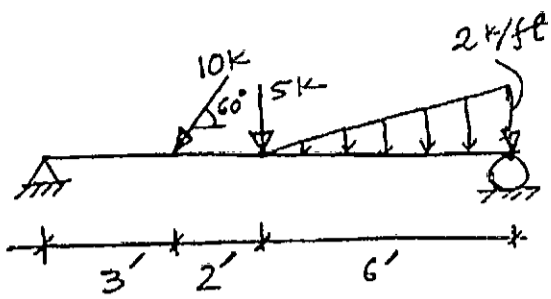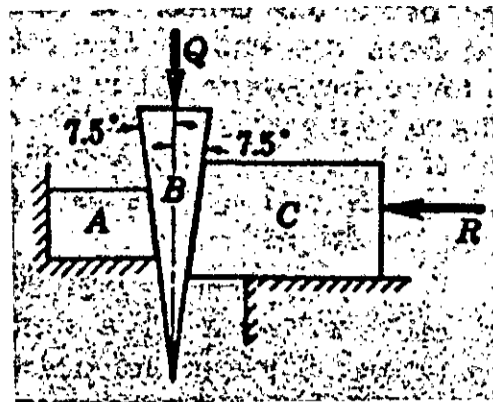
Fig. 1
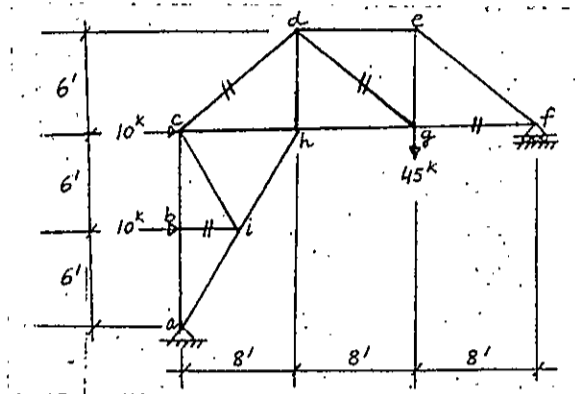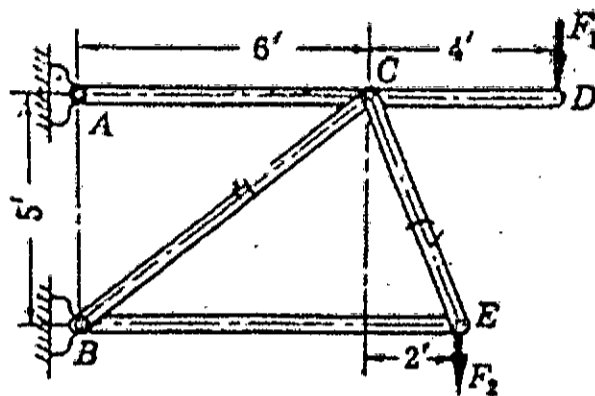

Fig. 2
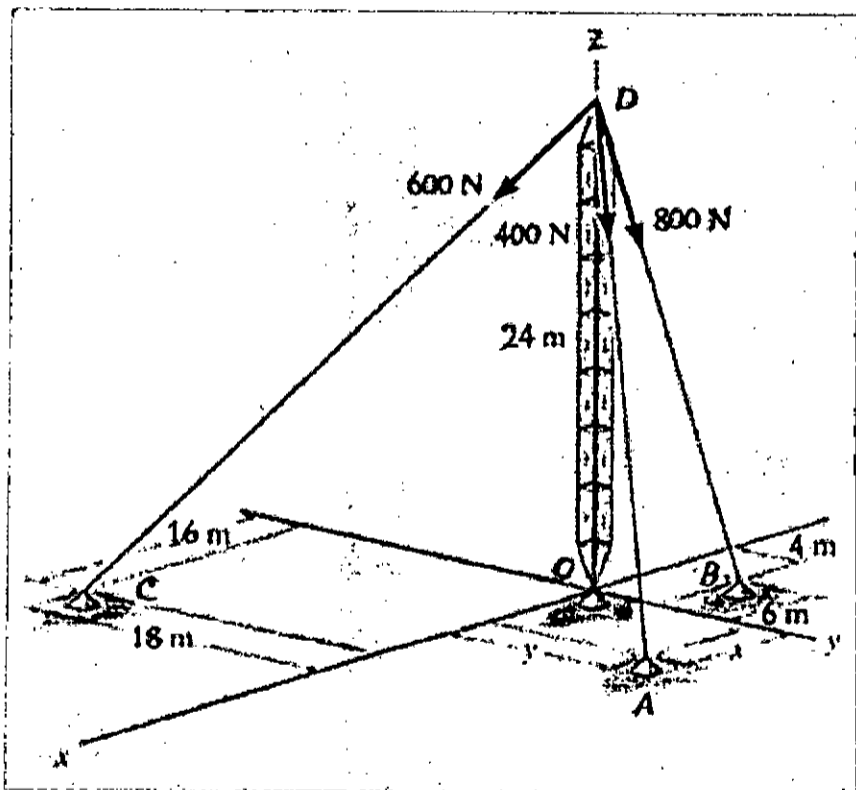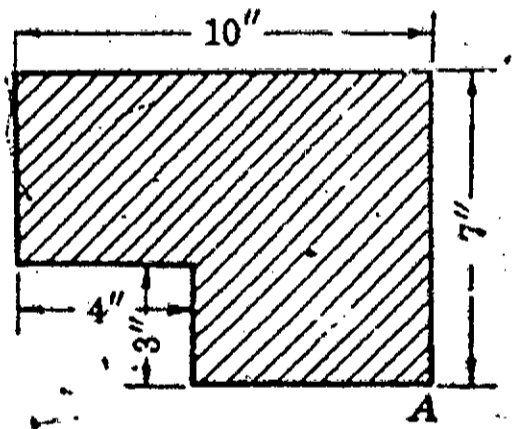
Fig. 3

Fig. 4

Fig. 5

Fig. 6
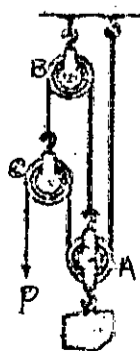

Fig. 7

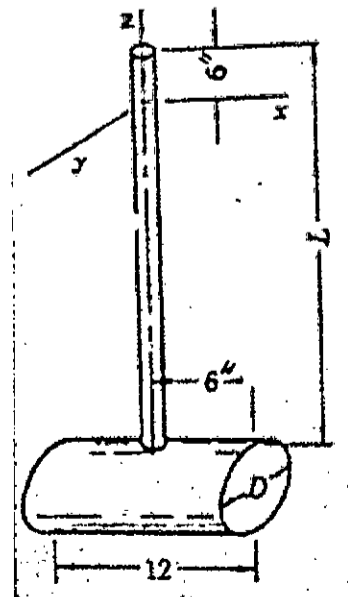
Fig. 8

CE 101

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Suppose a motor is driving a shaft with an angular acceleration $\alpha = 3t - 12$ rad/s^2 with an initial angular velocity of 15 rad/s with the same sense as the angular acceleration. Diameter of the shaft is 6 in. (i) What will be the maximum linear velocity of a particle on the shaft after 10 s.? (ii) What will be the linear tangential and normal accelerations of the particle at that time? **(10)**

(b) A flexible cable weighing 3 lb/ft is strung between two supports. One support is 80 ft higher than the other and the sag measured from the upper support is 130 ft. The tension in the cable at the lower support is 9000 lb. Calculate the following: (i) Distance between the two supports (ii) Total length of the cable (iii) Slope in degree at the upper support (iv) Tension at the upper support. **(12)**

(c) In Fig.9, $W_A = 64.4$ lb., $f_k = 0.2$ for A, $\theta = 30°$, $W_B = 966$ lb. and $D = 4$ ft. The cord from A wraps around the cylinder B. How many rotations does B make in 5 sec. after it is released from rest? **(13)**

Fig. 9
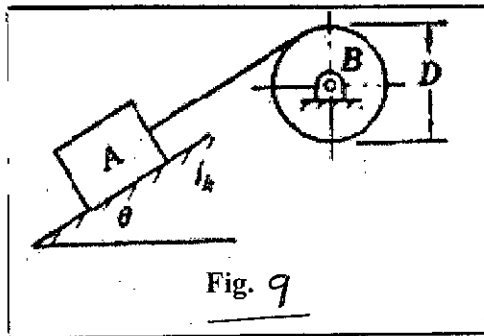
6. (a) By the method of virtual work, find the supporting force at B of the beam assembly shown in Fig. 10. **(10)**

Fig. 10
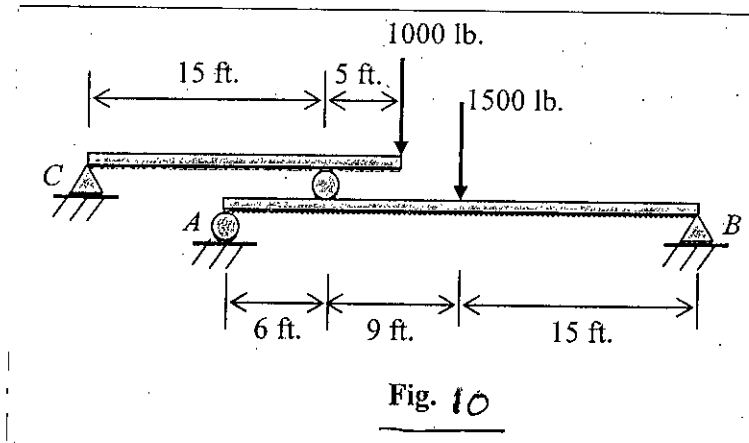
(b) A test sample A weighing 200 lb. is placed on a shaking table as shown in Fig. 11 for dynamic testing. The table is to be shaken with a simple harmonic motion of frequency 1 Hz. The coefficient of friction at the interface between the table and the test sample, $f_k = 0.4$. What is the maximum acceleration that can be applied to the table so that the sample does not slide or tip-over? What will be the maximum velocity and displacement of the table for that acceleration? **(12)**

CE 101
<u>Contd... Q. No. 6(b)</u>

Fig. 11
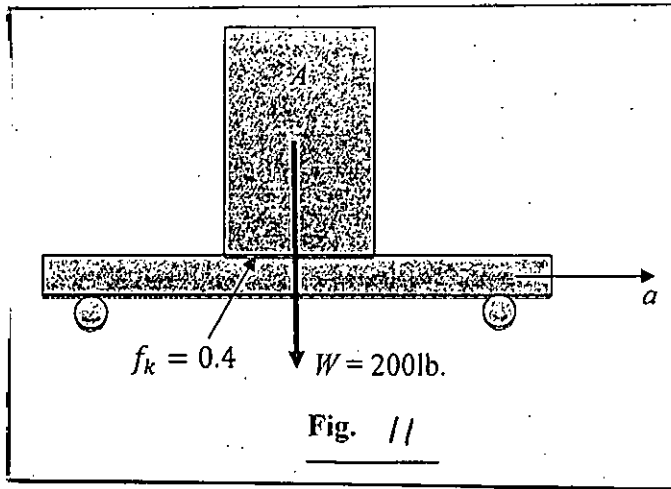
(c) In Fig. 12, body A weighs 400 lb , body B weighs 200 lb. Coefficient of static friction for all slipping surface is 0.3. What force Q causes impending motion towards the left if $\alpha = 15°$.　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**(13)**

Fig. 12
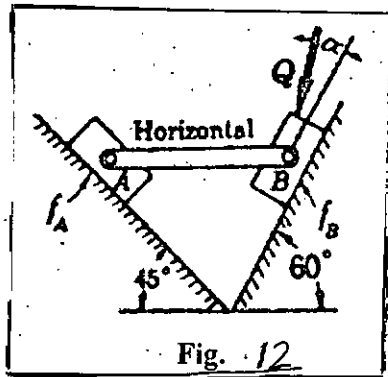
7.　(a) Suppose a 10 ft. long leaning bar (Fig. 13) supports a weight W = 400 lb. The bar is supported at the bottom with a stumble block A. Static coefficient of friction of block and the supporting surface is 1/3. What is the minimum weight of block A that can keep the bar in equilibrium? Use virtual work principle.　　　　　　　　　　　　**(10)**

Fig. 13
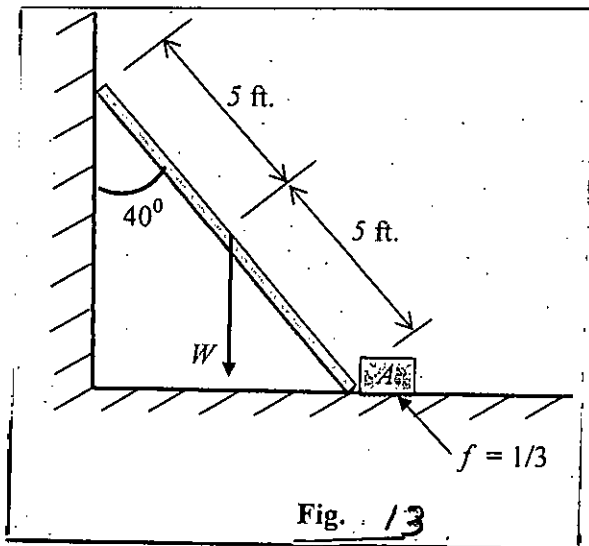
(b) The reciprocating follower A which weigh 6 lb., is moved upward by the cam B with constant acceleration (Fig.14). If the cam turns at a constant speed of 120 rpm and the force between the cam and the follower is 10 lb., determine the maximum velocity ad maximum acceleration of the follower.　　　　　　　　　　　　　　　　　　**(12)**

CE 101

Fig. 14
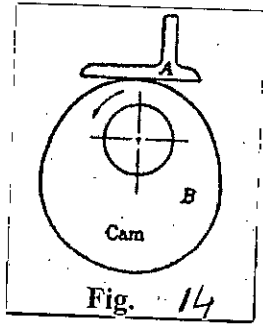
(c) The masses of A, B and C (Fig. 15) are respectively 1 slug, 2 slugs and 4 slugs. The cords are weightless and flexible. Sheaves D and E are considered free and weightless. After all elements are simultaneously released from rest, when A moves 40 ft. upward, what are the velocities and displacements of B and C?   **(13)**

Fig. 15
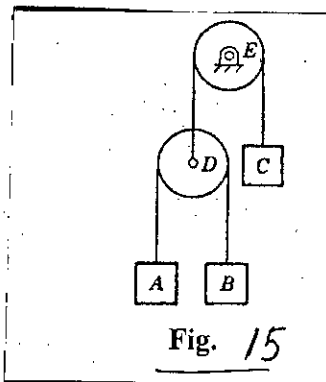
8.   (a) Two smooth spheres A and B are in equilibrium as shown in Fig 16. The weight of each sphere is 100 N and radius is 250 mm. Find the reaction forces at all contact points.   **(10)**

900

Fig. 16
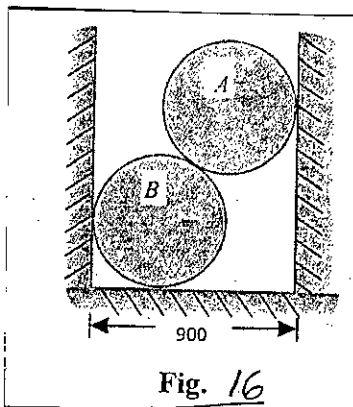
(b) The weight of the drum assembly B (Fig. 17) is 2576 lb. and its radius of gyration with respect to the axis of rotation is 14 in. The weight W is suspended from a cable which wraps about the D = 32 in. diameter. While W moves downward, the speed of the drum increased from 20 rpm to 40 rpm in 5 sec. If the frictional effects are negligible, what is the weight W?   **(12)**

Fig. 17
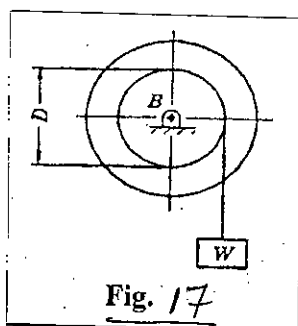
CE 101

<u>Contd... Q. No. 8</u>

(c) The 4-ft. solid cylinder A (Fig. 18) weighs 644 lb. and $\theta = 30°$. The weight of B is 192 lb. and the pulley C has negligible weight and friction. The system starts from rest. Determine the velocity of the c.g. of A while B is displaced by 10 ft.?　　　　　**(13)**

Fig. 18
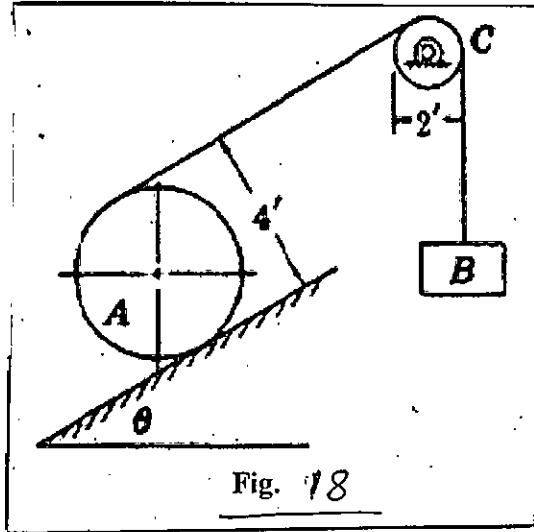
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations

Sub : **CE 103** (Surveying)

Full Marks : ~~280~~ 280   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Derive the equation to compute length of line between two points of different elevations from measurements on a vertical photograph. $(10^{2/3})$

   (b) Write down the sequences, operations and considerations of an Elevated Expressway Project Survey. (10)

   (c) A vertical photograph was taken at an altitude of 1200 meters above mean sea level. Determine the scale of the photograph for terrain lying at elevations of 80 meters and 300 meters if the focal length of the camera is 15 cm. (12)

   (d) Two points A and B having elevations of 500 m and 300 m respectively above datum appear on the vertical photograph having focal length of 20 cm and flying altitude of 2500 m above datum. Their corrected photographic co-ordinates are as follows: (14)

 | | Photographic Co-ordinates | |
Point	x (cm)	y (cm)
a	+ 2.65	+ 1.36
b	-1.92	+3.65

   Determine the length of the ground line AB.

2. (a) Write down the functions of a transition curve? $(6^{2/3})$

   (b) Determine the length of a transition curve for a 6 lane rural highway with the following available information- (12)

      i. Width of a single lane = 4 meter.

      ii. Design Speed = 90 km/hr.

      iii. $e_{max} = 0.07$; $f_{max} = 0.12$

   (c) Explain the term 'degree of curvature'? Considering side friction (f), establish a relationship among design speed (v), radius of curvature (R) and rate of supper-elevation (e). (14)

   (d) A parabolic vertical curve is to be set out connecting two uniform grades of +2.5 % and -3.5%. Chainage and reduced level of vertical curve (PVC) are 1250 meters and 30.5 meters respectively. The rate of vertical curvature (k) is 35. Calculate the chainage and reduced levels of PVI, PVT and midpoint of the curve. (16)

   Here, k is the length of curve per percent algebraic difference in Intersecting grades.

3. (a) Compare between: (10)

      (i) Height of instrument method of leveling; rise and fall method of leveling

      (ii) Square method of contouring and tacheometric method of contouring

   (b)List five important characteristics of contour. Draw typical contour of 'steep slope' and 'river'. $(8^{2/3})$

(c) A page of an old level book had been damaged by white ants and the readings marked "?" are missing. Compute the missing readings with the help of available readings and apply arithmetic check. **(20)**

Distance (in m)	Back-sight	Inter-sight	Fore-sight	Height of instrument	R.L	Remarks
	?			?	209.510	B.M
0		1.675			?	
30		?			210.425	
60		3.355			209.080	
?	0.840		?	209.52	?	Changing point
120		?			208.275	
150		?			210.635	Underside of bridge girder
?	?		2.630	?	?	?
210		?			206.040	
240		1.920			205.895	
270			?		205.690	

(d) List the natural errors in leveling. How can you conduct leveling for a pond or lake which is too wide to be sighted across? **(8)**

4. (a) List the main features of a tacheometer. Briefly describe a method to obtain the constants of tacheometer in the field. **(12 $^{2/3}$)**

(b) The elevation of a point P is to be determined by observations from two adjacent stations of a tacheometric survey. The staff was held vertically upon the point, and the instrument was fitted within an anallactic lens. The constants of the instrument are 100 and 0. Compute the elevation of the point P from the following data. Also calculate the distance of A and B from P. **(22)**

$$[D = ks \cos^2 \theta + C \cos \theta \, ; V = ks \frac{\sin 2\theta}{2} + C \sin\theta]$$

Instrument station	Height of instrument (meter)	Staff station	Vertical angle	Staff Readings	Elevation (m)
A	1.42	P	+ 5° 30′	2.230, 3.055, 3.880	77.75
B	1.40	P	− 3° 30′	1.785, 2.800, 3.815	97.14

(c) Compare between: **(12)**
  (i) 'Fly leveling' and 'Reciprocal leveling'.
  (ii) 'Indirect leveling' and 'Direct leveling'.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Assume reasonable values for any missing data

No.	Questions	Marks
5.	a) Describe the basic principle of determining the position of an object using global positioning system. What is remote sensing technology? List applications of remote sensing in civil engineering.	14
	b) A traverse was run with prismatic compass and the lengths and bearings of the lines observed are given bellow. Check whether or not the traverse closes. If not, balance it using the graphical method.	20

Table 1

Line	AB	BC	CD	DA
Length	105.8	142.5	188.8	188.9
Bearing	N40° 45′ W	N51° 30′ E	S48° 15′ E	S76° 45′ W

No.	Questions	Marks
	c) Explain various methods for determining the width of a river by chain surveying	$12\frac{2}{3}$
6.	a) A traverse survey was conducted and the data given in table 2 was noted. The observed back bearings and fore bearings of the lines are given. Check and correct the angles.	$20\frac{2}{3}$

Table 2

Line	Fore bearing	Back Bearing
AB	160° 33′	340° 33′
BC	58° 48′	238° 48′
CD	320° 47′	140° 47′
DE	280° 27′	100° 27′
EF	222° 52′	42° 52′
FA	114° 53′	294° 59′

No.	Questions	Marks
	b) Briefly describe the process of conducting the survey of an area, explain the steps involved.	10
	c) A 30 m long tape was standardized at 20 °C and under a pull of 100 N. The tape was used to measure a distance AB when the temperature was 45 °C and the pull was 150N. The tape was supported at the ends only. Find the corrections per tape length if the cross section of the tape was 4 mm^2, the unit weight of the tape is 0.0786 N/ mm^3 and the coefficient of thermal expansion of the tape material is 11.5×10^{-6}/ °C. E=2000000 kN/m^2.	11
	d) Explain the difference between contouring and leveling.	5

No.	Questions	Marks
7.	a) Write short notes on two major Astronomical Corrections.	12
	b) The altitudes of a star at upper and lower culmination are 72°18′ and 21°30′, respectively, both on the north side of the zenith. Find the declination of the star and latitude of the place.	12
	c) Find the shortest distance between A ($\phi = 140°E$, $\theta = 20.5°S$) and B ($\phi = 70°E$, $\theta = 20.5°S$). Also, find the distance between A and B along a line of constant latitude.	$16\frac{2}{3}$
	d) Define magnetic declination. List the factors upon which the diurnal variation depends.	6

8.	a)	Define curvature correction for volume computation. How would apply curvature correction for curved embankment with end cross-section A_1 and A_2?	$12\frac{2}{3}$		
	b)	To determine the height of a chimney, a theodolite was kept at two stations A and B, 200 m apart, station A being nearer to the chimney. The readings at the benchmark (RL = 1020.375 m) were 1.35 m from station A and 2.15 m from B. The vertical angles to the top of the chimney were 19°30′ and 8°15′ from stations A and B, respectively. Find the horizontal distance and RL of the top of the chimney.	16		
	c)	A single-level section has a formation width of 7.5 m and side slopes of 2:1. The depth of cutting at the center at 30-m intervals are 1.8 m, 2.175 m, 2.55 m, 2.925 m, and 3 m. Find the volume of earthwork in the length of 120 m. Use the trapezoidal formula.	12		
	d)	Write various methods of traversing.	6		

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1   B. Sc. Engineering Examinations 2018-2019
Sub : **CHEM 103** (Chemistry - I)
Full Marks : 210   Time : 3 Hours
The figures in the margin indicate full marks.
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Derive de Broglie's wave equation and show that Bohr's principle of quantisation of angular momentum of a moving electron can be derived from de Broglie concept. Prove that this equation is not applicable for large particle.   **(12)**

   (b) Explain Sommerfeld's extension of Bohr's Atom Model.   **(11)**

   (c) Derive the Schrödinger wave equation for the motion of a particle in three dimension.   **(12)**

2. (a) What are the features favouring the formation of ionic bond. Explain the presence of covalent character in some ionic compounds.   **(10)**

   (b) Predict the magnetic property and bond order of Boron and Carbon molecules showing molecular orbital energy level diagram.   **(10)**

   (c) What are the differences between bonding molecular orbitals and antibonding orbitals?   **(7)**

   (d) Explain, why N_2 moleculer is more stable than NO molecule.   **(8)**

3. (a) How does heat evolve or absorb during dissolution of ionic compound to a polar solvent? Explain with suitable example.   **(10)**

   (b) Distinguish between the following terms:

   (i) Henry's law constant and Bunsen absorption coefficient.

   (ii) Mutual solubility temperature and critical solution temperature.

   (iii) Ideal solution and saturated solution

   (iv) Integral heat of solution and integral heat of dilution.   **(16)**

   (c) When the two immiscible liquids chlorobenzene and water are boiled at a pressure of 734.4 mm Hg, then the boiling point is 90°C, while the ratio of weight of chlorobenzene to water is 2.47 in the distillate. Find the molar mass of chlorobenzene. Vapour pressure of water at 90°C is 526.0 mm Hg.   **(9)**

4. (a) Derive an equation to determine the variation of heat of reaction with temperature at constant pressure.   **(10)**

   (b) Thermodynamically prove that the elevation of boiling point of solutions is proportional to the molality of the substance in the solution and show the calculation of molecular weight of the substance dissolved in the solution from boiling point elevation.   **(12)**

CHEM 103

Contd..... Q. No. 4

(c) Derive Van't Hoff equation for osmotic pressure. **(7)**

(d) A 35 g sample of haemoglobin is dissolved in water and the total volume of the solution is made to 1.0 liter. The osmotic pressure of the solution is 10.0 torr at 25°C. Calculate the molar mass of haemoglobin. **(6)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What do you understand by setting and hardening of cement? Discuss the colloidal theory of Michaelis for setting and hardening of cement. **(9)**

(b) "Hardening of cement is mainly due to hydrolysis and hydration of the components of cement." Justify the comment with appropriate chemical reactions. **(10)**

(c) Discuss the advantages and disadvantages of using fly ash into cement. **(8)**

(d) What do you mean by dusting of clinker? Why this phenomenon is observe? **(8)**

6. (a) Discus how do the colloidal particles acquire electrical charge? **(9)**

(b) What is zeta potential? What is the effect of electrolyte concentration on zeta potential? **(10)**

(c) What do you mean by sedimentation of a colloidal solution? Write down the expression of Stoke's law. **(8)**

(d) State Hardy-Schulze rule for coagulation. **(8)**
Aluminum hydroxide forms a positively charged sol. Which of the following ionic substances should be most effective in coagulating the sol and why? Nacl, $CaCl_2$, $Fe_2(SO_4)_3$ and K_3PO_4.

7. (a) The solubility product of $PbBr_2$ is 8.9×10^{-6}. Determine the molar solubility (a) in pure water, (b) in 0.20 M KBr solution, (c) in 0.20 M $Pb(NO_3)_2$ solution. **(9)**

(b) Calculate the pH of 1.00 L of the buffer 1.00 M $CH3COONA$/1.00 M Ch_3COOH before and after the addition of (a) 0.080 mol NaOH, (b) 0.12 mol HCL. (Assume that there is no change in volume. The K_a of CH_3COOH is 1.8×10^{-5}) **(10)**

(c) Which of the following ionic compounds will be more soluble in acid solution than in water? (a) $BaSO_4$, (b) $PbCl_2$, (c) $Fe(OH)_3$, (d) $CaCO_3$. **(8)**

(d) Making mayonnaise involves beating oil into small droplets in water in the presence of egg yolk. What is the purpose of the egg yolk? **(8)**

CHEM 103

8. (a) What do you mean by silica content in water. How the presence of silica in water impose detrimental effects? How it can be removed? **(9)**

(b) What do you mean by flocculation of water? Mention the name of two commonly used flocculants. Discuss how it works. **(10)**

(c) How ozonization method can be employed to sterilize water? **(8)**

(d) Discuss softening of water by ion exchange process? How the activities of Na-cation exchanger and H-cation exchanger are regenerated? **(8)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2018-2019

Sub : **HUM 355** (Sociology)

Full Marks: 140   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) 'Sociological imagination is a systematic way of analyzing social relationship without personal biasness'-Explain. **(10)**

    (b) Critically explain functionalist theoretical perspective of sociology. **(13⅓)**

2. (a) Define social stratification. Explain caste system and social class system of social stratification. **(10)**

    (b) Discuss various roles of social norms and social values for developing a normative system of a society. **(13⅓)**

3. (a) Evaluate the roles of family, peers and educational institute as important agents of socialization. **(10)**

    (b) Explain G.H. Mead's theory of self development. **(13⅓)**

4. Write short notes on any three of the following: **(23⅓)**

    (a) Anticipatory socialization and re- socialization.
    (b) Ethnocentrism and cultural relativism.
    (c) Conflict view of mass media.
    (d) Types of social mobility.

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define environment and pollution. **(3⅓)**

    (b) How can we save the environment and make it greener? **(10)**

    (c) What is meant by the 4R's? **(10)**

HUM 355

6. (a) Explain the socio-economic features of pre-industrial, industrial and post-industrial societies. **(10)**

    (b) 'Private property is the terra ferma of capitalism'- Explain this statement on the basis of the nature of capitalism. **(13 $\frac{1}{3}$)**

7. (a) Define social disorganization and social problem. **(5 $\frac{1}{3}$)**

    (b) What is meant by crime, deviance, white collar crime and juvenile delinquency? **(10)**

    (c) What do you understand by work? Explain the nature of work. **(8)**

8. Write short notes on any <u>THREE</u> of the following: **(23 $\frac{1}{3}$)**

    (a) Demographic transition theory

    (b) Causes of crime

    (c) Red category industry

    (d) Social consequences of industrial revolution.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2018-2019

Sub : **HUM 375** (Government)

Full Marks: 140   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Describe various types of sovereignty with examples. $(11\frac{1}{3})$

    (b) What is meant by the term 'Rights'? Analyze the legal rights of a citizen in a state.   **(12)**

2. (a) Classify democratic types of government with relevant examples. $(11\frac{1}{3})$

    (b) Define democracy. Which conditions are necessary for the success of Democracy?   **(12)**

3. (a) Make a comparison between parliamentary and presidential forms of government. $(11\frac{1}{3})$

    (b) What is good governance? Examine the agenda for good governance.   **(12)**

4. Write short notes on any three (3) of the following: $(23\frac{1}{3})$

    (a) Local government

    (b) Constitutional monarchy

    (c) Civil society

    (d) Shadow cabinet.

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What is nationalism? Explain the merits and demerits of nationalism in a modern

    state. $(11\frac{1}{3})$

    (b) Define constitution. Discuss the basic characteristics of a good enough constitution.   **(12)**

HUM 375

6. (a) What do you mean by bureaucracy? Discuss the main features of the Max Weber's ideal type of bureaucracy with limitations. $(11\frac{1}{3})$

(b) Define NGOs. Discuss the role of NGOs in socio-economic development of developing countries like Bangladesh. (12)

7. (a) What is foreign policy? Explain the determinants of foreign policy of Bangladesh. $(11\frac{1}{3})$

(b) Discuss the significance of the language movement of 1952 in the political history of Bangladesh. (12)

8. Write short notes on any three of the following: $(23\frac{1}{3})$

(a) Bangladesh constitution
(b) SAARC
(c) State
(d) E-government.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2018-2019

Sub : **PHY 101** (Physical Optics, Waves and Oscillations, Heat and Thermodynamics)

Full Marks: 210   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What are Newton's rings? Explain why Newton's rings are circular.   **(10)**

    (b) Describe the geometrical features of Fresnel's biprism. Discuss how it can be used
    to find the wavelength of monochromatic light.   **(18)**

    (c) A parallel beam of sodium light of wavelength $5890 \overset{\circ}{A}$ strikes a film of oil floating
    on water. When viewed at an angle of 30° from the normal, 8th dark band is seen.
    Determine the thickness of the film. Refractive index of oil is 1.46.   **(7)**

2. (a) From the expression of intensity for diffraction of light due to a single slit, find the
    condition of secondary maxima.   **(8)**

    (b) Discuss the construction and theory of a plane transmission grating and obtain the
    expression of intensity corresponding to the principle maxima.   **(20)**

    (c) Diffraction pattern of a single slit of width 0.5 cm is formed by a lens of focal
    length 40 cm. Calculate the distance between the first dark and next bright fringe from

    the centre. Wavelength used is $4890 \overset{\circ}{A}$.   **(7)**

3. (a) Write down Brewster's law and Malus' law.   **(8)**

    (b) Discuss how light can be polarized by reflection and refraction and explain this
    polarization mechanism by Fresnel's theory.   **(20)**

    (c) Two polaroids are so arranged that the amount of light transmitted through them is
    maximum. What will be the percentage reduction in the intensity of the incident light
    when the analyzer is rotated through 30°?   **(7)**

4. (a) State and prove Carnot's theorem.   **(15)**

    (b) What are the thermodynamic potentials? Deduce the Maxwell's thermodynamic
    relations by using the thermodynamic functions.   **(20)**

PHY 101

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) State the laws of thermodynamics. **(10)**

(b) Show that the entropy remains constant in a reversible adiabatic process and increases in an irreversible process. **(15)**

(c) A Carnot engine whose temperature of the source is 927°C takes 200 calories of heat at this temperature and rejects 100 calories of heat in the sink or temperature 27°C. Calculate the efficiency of the engine. **(10)**

6. (a) What is degrees of freedom? State the law of equipartition of energy. Establish a relationship between the ratio of two specific heat and the degrees of freedom. **(15)**

(b) Derive an expression for the r. m. s. velocity of a gas molecule by using the Maxwell's law of distribution of velocities expression. **(10)**

(c) Define Clausius- Clapeyron equation for latent heat. **(10)**

7. (a) What are free, damped and forced oscillations? **(6)**

(b) A particle executing damped harmonic motion is subjected to an external periodic force. Establish the differential equation of the motion of particle. Solve the differential equation and obtain the expression for its maximum amplitude. **(22)**

(c) A harmonic oscillator of quality factor 12 is subjected to sinusoidal applied force of frequency one and half times the natural frequency of the oscillator. If the damping is small, obtain the amplitude of the forced oscillation in terms of maximum amplitude. **(7)**

8. (a) What are reverberation and reverberation time? **(6)**

(b) Derive the expression for the growth and decay of sound intensity inside a room. Obtain an expression for the reverberation time. **(22)**

(c) The volume of a room is 800 m³. The area of wall, floor and ceiling are 150, 110 and 120 cm², respectively. The average absorption coefficients for walls, ceiling and floor are 0.03, 0.80 and 0.06, respectively. Calculate the average sound absorption coefficient and the reverberation time. **(7)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2018-2019

Sub: **MATH 137** (Differential and Integral Calculus, Matrices)

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Find values of the constants k and m, if possible, that will make the function f continuous everywhere. **(15)**

$$f(x) = \begin{cases} x^2 + 5, x > 2 \\ m(x+1) + k, -1 < x \leq 2 \\ 2x^3 + x + 7, \ x \leq -1 \end{cases}$$

(b) State L' Hospital's rule. Hence evaluate $\lim_{x \to 0}\left[\dfrac{1}{x^2} - \dfrac{1}{\sin^2 x}\right]$. **(10)**

(c) Apply Leibnitz's theorem to prove $\dfrac{d^n}{dx^n}\left(x^{n-1}e^{1/x}\right) = (-1)^n \dfrac{e^{1/x}}{x^{n+1}}$. **(10)**

2. (a) If $f(x) = x^4 - 5x^3 + 9x^2$ then use the first and second derivatives of f to determine the intervals on which f is increasing, decreasing, concave up and concave down. Also locate all the inflection points. **(15)**

(b) State Euler's theorem for homogeneous function. Hence verify Euler's theorem for the following function: **(10)**

$$u = \frac{x^{1/4} + y^{1/4}}{x^{1/5} + y^{1/5}}.$$

(c) Expand $y = e^x \cos x$ in a series of ascending power of x. **(10)**

3. (a) State and give geometrical interpretation of Rolle's theorem. Verify the hypotheses of Rolle's theorem for **(12)**

$$f(x) = 2x^3 + x^2 - 4x - 2 \quad over\left[-\sqrt{2}, \sqrt{2}\right].$$

(b) If $x\cos\alpha + y\sin\alpha = p$ touches the curve $\dfrac{x^m}{a^m} + \dfrac{y^m}{b^m} = 1$, then show that

$$(a\cos\alpha)^{m/m-1} + (b\sin\alpha)^{m/m-1} = p^{m/m-1}. \tag{12}$$

(c) Find the pedal equation of the parabola $y^2 = 4b(x + b)$. **(11)**

4. (a) Write down geometric interpretation of integration and the drawbacks in the study of integral calculus. **(11)**

MATH 137

Contd... Q. No. 4

(b) Evaluate the following: **(24)**

(i) $\displaystyle\int \frac{dx}{\sqrt{\sin^5 x \cos^7 x}}$

(ii) $\displaystyle\int \frac{dx}{3 + 2\sin x + \cos x}$

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Find a reduction formula for $\int e^{ax}\cos^n x\,dx$ and hence evaluate $\int e^{2x}\cos^4 x\,dx$. **(15)**

(b) Evaluate $\displaystyle\int_0^\pi \frac{x\sin x}{1 + \cos^2 x}\,dx$. **(10)**

(c) Evaluate $\displaystyle\lim_{n\to\infty}\left[\left(2 + \frac{1}{n^2}\right)^{\frac{1}{n^2}}\left(2 + \frac{2^2}{n^2}\right)^{\frac{2}{n^2}}\left(2 + \frac{3^2}{n^2}\right)^{\frac{3}{n^2}}\cdots\cdots\cdots\left(2 + \frac{n^2}{n^2}\right)^{\frac{n}{n^2}}\right]$. **(10)**

6. (a) Evaluate $\displaystyle\int_0^{\frac{\pi}{2}} \frac{dx}{\sqrt{1 - \frac{1}{2}\sin^2 x}}$ **(10)**

(b) Evaluate $\displaystyle\iiint_R \frac{1}{\sqrt{x+y}}\,dy\,dx\,dz$, where $R : x \leq y \leq z,\ 0 \leq x \leq z,\ 1 \leq z \leq 4$. **(10)**

(c) Find the inverse of the matrix $A = \begin{bmatrix} 1 & 2 & -2 & -1 \\ -1 & -4 & 4 & 0 \\ 2 & -7 & 4 & -7 \\ 1 & 6 & -5 & 1 \end{bmatrix}$ by using elementary row

transformations and hence check your result. **(15)**

7. (a) Define Hermitian, Periodic and Nilpotent matrices with example. **(8)**

(b) Determine the values of λ and μ such that the following system of equation in unknowns x_1, x_2 and x_3 have (i) unique solution, (ii) more than one solution and (iii) no solution: **(12)**

$$x_1 + 2x_2 + x_3 = 8$$
$$2x_1 + x_2 + 3x_3 = 13$$
$$3x_1 + 4x_2 - \lambda x_3 = \mu$$

(c) Define rank of a matrix with applications. Find the canonical form and the rank of the following matrix A where **(15)**

MATH 137

Contd... Q. No. 7(c)

$$A = \begin{bmatrix} 1 & 2 & 1 & 3 \\ 2 & 3 & -3 & -2 \\ 3 & 8 & 1 & 3 \\ 3 & 10 & -1 & -3 \end{bmatrix}.$$

8. (a) State Cayley-Hamilton theorem. Verify Cayley-Hamilton theorem and find A^4 for

the matrix $A = \begin{bmatrix} 4 & -1 & 1 \\ -1 & 4 & -1 \\ 1 & -1 & 4 \end{bmatrix}.$ **(15)**

(b) Find the eigenvalues and maximum set of linearly independent vectors of the matrix **(20)**

$$A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}.$$

Is the matrix A diagonalizable? If so, write down a nonsingular matrix P that diagonalizes A and hence determine the corresponding diagonal matrix D.