

The figures in the margin indicate full marks.

Assume reasonable values if necessary.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) In Fig. 1(a), slider block *B* moves to the right with a constant velocity of 300 mm/s. Determine (i) the velocity of slider block *A*, (ii) the velocity of portion *C* of the cable, (iii) the velocity of portion *D* of the cable, (iv) the relative velocity of portion *C* of the cable with respect to slider block *A*. (15)
- (b) Knowing that at the instant shown in Fig. 1(b), bar *AB* has a constant angular velocity of 4 rad/s clockwise, determine the angular acceleration of (i) bar *BD*, (ii) bar *DE*. (20)
2. (a) As shown in Fig. 2(a), a 600-g ball *A* is moving with a velocity of magnitude 6 m/s when it is hit by a 1-kg ball *B* which has a velocity of magnitude 4 m/s. Knowing that the coefficient of restitution is 0.8 and assuming no friction, determine the velocity of each ball after impact. (18)
- (b) The system shown in Fig. 2(b) is at rest when a constant 150-N force is applied to collar *B*. Neglecting the effect of friction, determine (i) the time at which the velocity of collar *B* will be 2.5 m/s to the left, (ii) the corresponding tension in the cable. (17)
3. (a) As shown in Fig. 3(a), the system is at rest when a constant 250-N force is applied to block *A*. Neglecting the masses of the pulleys and the effect of friction in the pulleys and assuming that the coefficients of friction between block *A* and the horizontal surface are $\mu_s = 0.25$ and $\mu_k = 0.20$, determine (i) the velocity of block *B* after block *A* has moved 2 m, (ii) the tension in the cable. (18)
- (b) In Fig. 3(b), the 15-kg block *B* is supported by the 25-kg block *A* and is attached to a cord to which a 225-N horizontal force is applied as shown. Neglecting friction, determine (i) the acceleration of block *A*, (ii) the acceleration of block *B* relative to *A*. (17)
4. (a) As shown in Fig. 4(a), a worker uses high-pressure water to clean the inside of a long drain pipe. If the water is discharged with an initial velocity of 11.5 m/s, determine (i) the distance "*d*" to the farthest point *B* on the top of the pipe that the worker can wash from his position at *A*, (ii) the corresponding angle " α ". (15)
- (b) As shown in Fig. 4(b), a uniform rectangular plate has a mass of 5 kg and is held in position by three ropes. Knowing that $\theta = 30^\circ$, determine, immediately after rope *CF* has been cut, (i) the acceleration of the plate, (ii) the tension in ropes *AD* and *BE*. (20)

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SECTION – B

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

5. (a) Three cables are connected at A , where the forces \mathbf{P} and \mathbf{Q} are applied as shown in Fig. Q. 5(a). Knowing that $Q = 0$, find the value of P for which the tension in cable AD is 305 N. (20)
- (b) In Fig. Q. 5(b), the bracket BCD is hinged at C and attached to a control cable at B . For the loading shown, determine (i) the tension in the cable, (ii) the reaction at C . (15)
6. (a) A force and couple act as shown in Fig. Q. 6(a) on a square plate of side $a = 635$ mm. Knowing that $P = 270$ N, $Q = 180$ N, and $\alpha = 50^\circ$, replace the given force and couple with a single force applied at a point located (i) on line AB , (ii) on line AC . In each case, determine the distance from A to the point of application of the force. (15)
- (b) Locate the x and y coordinates of the center of gravity of the sheet-metal form shown in Fig. Q. 6(b). (20)
7. (a) Determine the force in members DF , EF , and EG of the truss shown in Fig. Q. 7(a). (17)
- (b) For the frame and loading shown in Fig. Q. 7(b), determine the components of the forces acting on member CFE at C and F . (18)
8. (a) Block A supports a pipe column and rests on wedge B as shown in Fig. Q. 8(a). Knowing that the coefficient of static friction at all surfaces of contact is 0.25 and that $\theta = 45^\circ$, determine the smallest force \mathbf{P} required to raise block A . (18)
- (b) Determine the moment of inertia and the radius of gyration of the shaded area shown in Fig. Q. 8(b) with respect to the x axis. (17)
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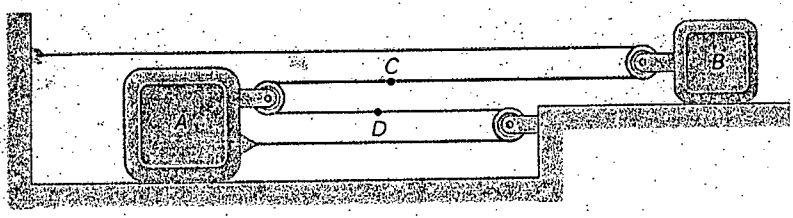


Fig. 1(a)

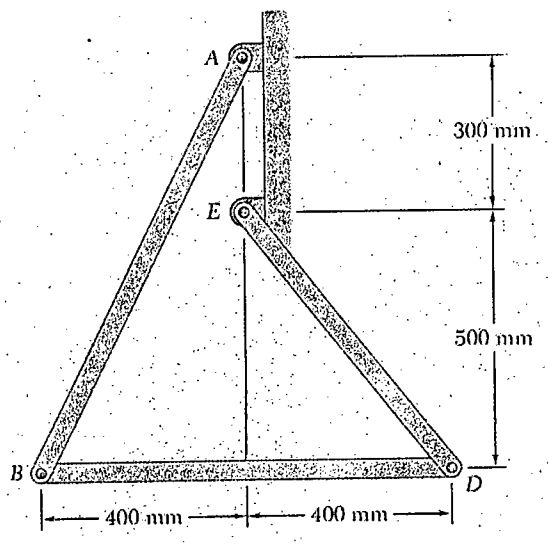


Fig. 1(b)

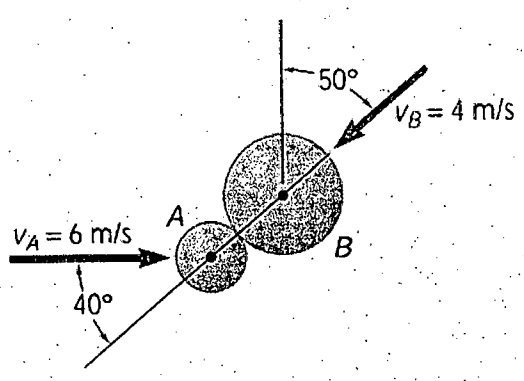


Fig. 2(a)

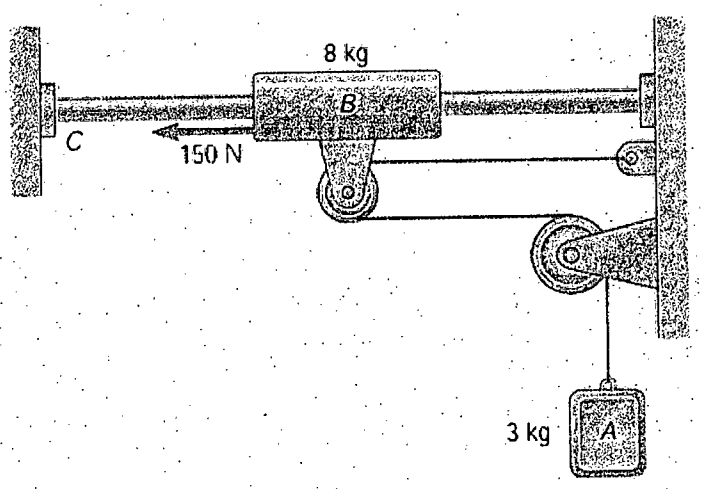


Fig. 2(b)

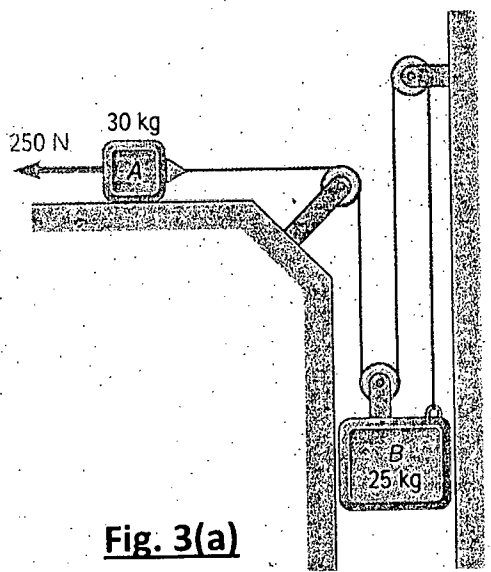


Fig. 3(a)

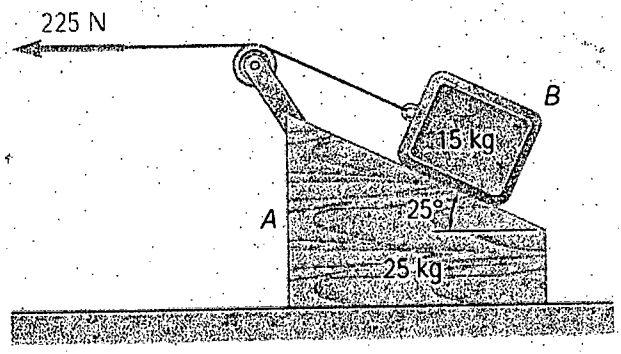


Fig. 3(b)

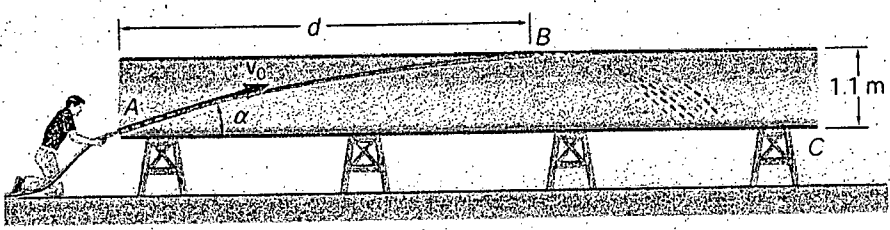


Fig. 4(a)

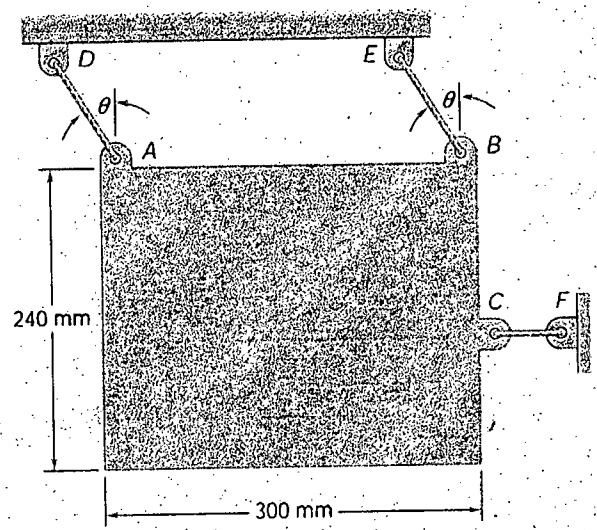


Fig. 4(b)

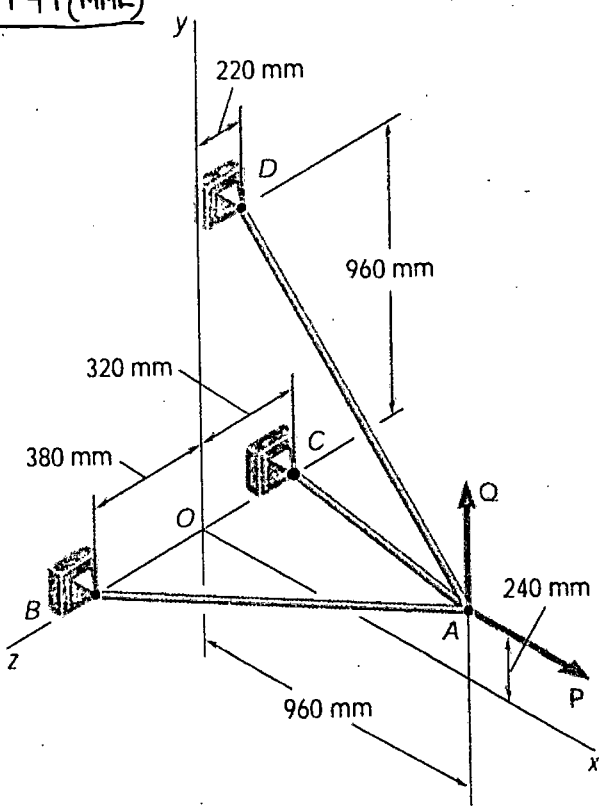


Fig. for Q. No: 5(a)

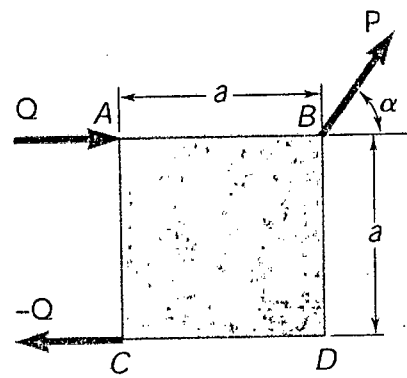


Fig. for Q. No: 6(a)

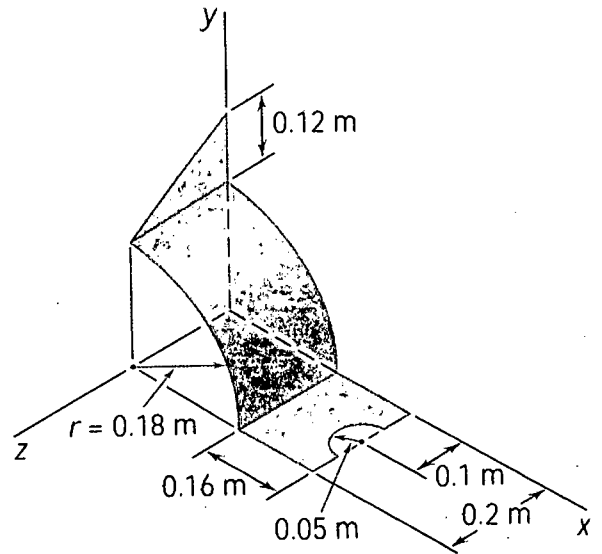


Fig. for Q. No: 6(b)

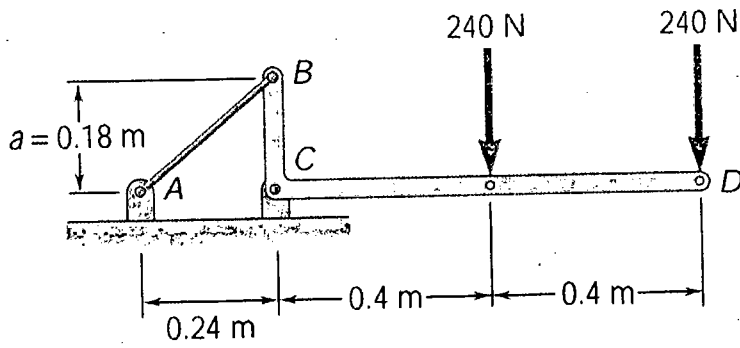


Fig. for Q. No: 5(b)

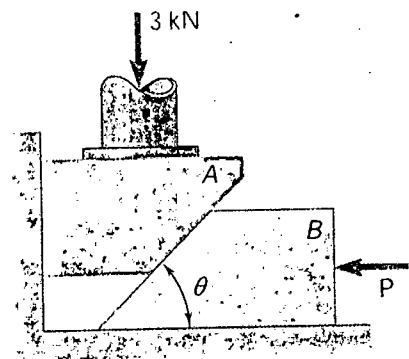


Fig. for Q. No: 8(a)

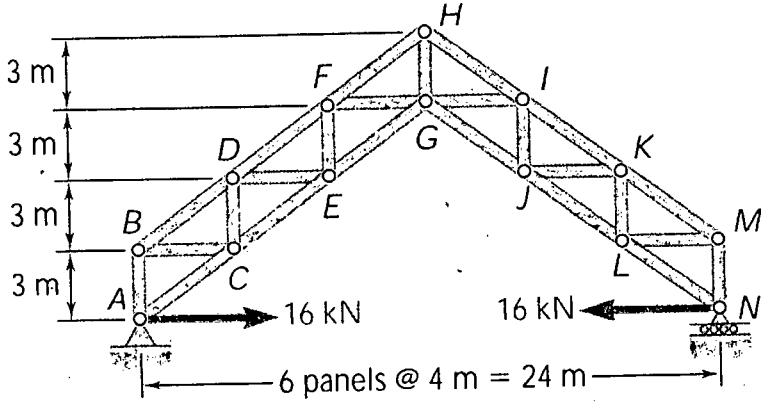


Fig. for Q. No: 7(a)

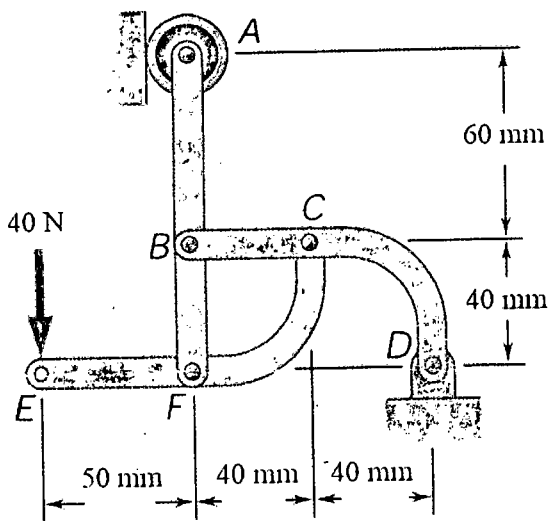


Fig. for Q. No: 7(b)

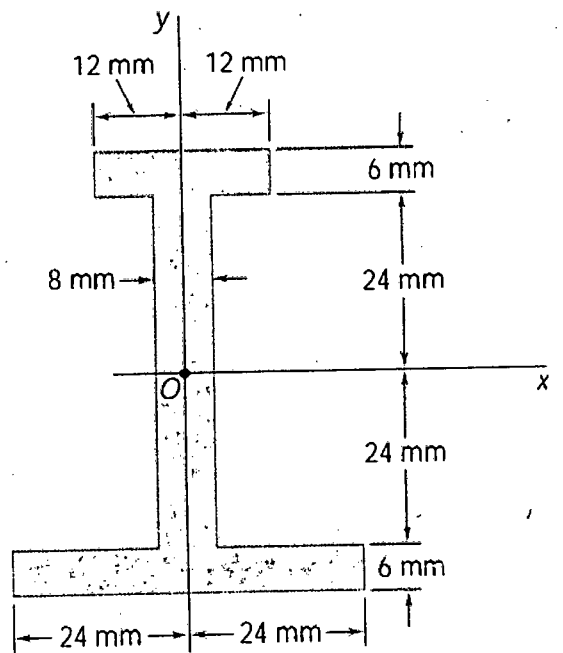


Fig. for Q. No: 8(b)

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE** including Q. No. 1 as compulsory.

1. (a) Explain with reference to the context **any two** of the following: (15)
- (i) “And so the house came to be haunted by the unspoken phrase, “There must be more money! There must be more money!”
 - (ii) People were attracted to him as bees are attracted to cosmos or dahlia stalks.
 - (iii) “We’ve got to have rules and obey them.”
- (b) Answer any one of the following: (15)
- (i) Make a critical appreciation of the story “An Astrologer’s Day”.
 - (ii) Do you support the writer’s claim that when the white man turns tyrant, it is his own freedom that he destroys?
- (b) Answer **any three** of the following: (15)
- (i) Why does Paul confuse luck with money?
 - (ii) “There aren’t any grown-ups. We shall have to look after ourselves”. Who said this to whom and why?
 - (iii) What does the “snake thing” signify in the story “Fire on the Mountain”?
 - (iv) Give a description of the place where the astrologer sat for his profession.
 - (v) When does the writer’s elephant shooting take place?
2. (a) Recast and correct **any ten** of the following sentences: (15)
- (i) The data is incorrect.
 - (ii) The six students were conversing excitedly with each other.
 - (iii) It was I who he wanted to come.
 - (iv) We had a real good time.
 - (v) I was angry with the result.
 - (vi) We had two thirds of a cake.
 - (vii) He is here now, and I will not speak to him.
 - (viii) I was disinterested in the story.
 - (ix) Keep off of the glass.
 - (x) He is comparatively better today.
 - (xi) There is no place in the bench.
 - (xii) Patterson is to be the first choice, and Donahue and Rikey the second and third.

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Contd ... Q. No. 2

(b) Give the meanings of and make sentences with **any ten** of the following words: **(15)**

Agitate, boulder, chasm, depict, equitably, forbearance, gust, hoarse, inquisitive, laud, oration, swarm.

3. Amplify any one of the following ideas: **(30)**

(i) Hope for the best, but prepare for the worst.

(ii) When in Rome, do as the Romans do.

4. Write a précis of the following passage: **(30)**

Fidel Castro's government emphasized social projects to improve Cuba's standard of living, often at the cost of economic development. Major emphasis was placed on education, and during the first 30 months of Castro's government, more classrooms were opened than in the previous 30 years. The Cuban primary education system offered a work-study program, with half of the time spent in the classroom, and the other half in a productive activity. Health care was nationalized and expanded, with rural health centers and urban polyclinics opening up across the island to offer free medical aid. Universal vaccination against childhood diseases was implemented, and infant mortality rates were reduced dramatically. A third part of this social program was the improvement of infrastructure. Within the first six months of Castro's government, 600 miles of roads were built across the island, while \$300 million was spent on water and sanitation projects. Over 800 houses were constructed every month in the early years of the administration in an effort to cut homelessness, while nurseries and day-care centers were opened for children and other centers opened for the disabled and elderly. Castro used radio and television to develop a "dialogue with the people", posing questions and making provocative statements. His regime remained popular with workers, peasants, and students, who constituted the majority of the country's population, while opposition came primarily from the middle class; thousands of doctors, engineers and other professionals emigrated to Florida in the U.S.A, causing an economic brain drain. Castro was committed to social equality. He wanted a system that provided the basic needs to all – enough to eat, health care, adequate housing and education. The authoritarian nature of the Cuban Revolution stems largely from his commitment to that goal. Castro was convinced that he was right, and that his system was for the good of the people. Thus, anyone who stood against the revolution stood also against the Cuban people and that, in Castro's eyes, was simply unacceptable.

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SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** questions including Q. No. 5 as compulsory.

5. Read the following passage carefully and answer the questions that follow:

(45)

Education has always had two objects: on the one hand, to give skill; and on the other, to impart a vaguer thing which we may call wisdom. The role of skill has become very much larger than it used to be and is increasingly threatening to oust the role of wisdom. At the same time it must be admitted that wisdom in our world is useless except for those who realize the great part played by skill, for it is increase of skill that is the distinctive feature of your world.

Although scientific skill is necessary, it is by no means sufficient. A dictatorship of men of science would very soon become horrible. Skill without wisdom may prove to be purely destructive. For this reason, if for no other, it is of great importance that those who receive a scientific education should not be merely scientific, but should have some understanding of that kind of wisdom which, if it can be imparted at all, can only be imparted by the cultural side of education. Science enables us to know the means to any chosen end, but it does not help us to decide upon what ends should be pursued. If you wish to exterminate the human race, it will show you how to do it. If you wish to make the human race so numerous that all are on the very verge of starvation, it will show you how to do that. If you wish to secure adequate prosperity for the whole human race, science will tell you what you must do. But it will not tell you whether one of these ends is more desirable than another. Nor will it give you that instinctive understanding of human beings that is necessary if your measures are not to arouse fierce opposition which only ferocious tyranny can quell. It cannot teach you patience, it cannot teach you sympathy, it cannot teach you a sense of human dignity. These things, insofar as they can be taught in formal education, are mostly likely to emerge from the learning of history and great literature.

- (i) What should, according to the writer, be the aim of education?
- (ii) Why is increase of skill a distinctive feature of our world?
- (iii) What danger does the writer see in the present emphasis on imparting skill?
- (iv) What knowledge does science impart to us?
- (v) Why should we study history and great literature?
- (vi) What is the distinction between 'Knowledge' and 'wisdom'? Can the latter be imparted?
- (vii) Does the present system of education in Bangladesh take into consideration the viewpoints expressed in the passage?

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6. (a) Write in brief the importance and the structure of a successful business letter. (10)
- (b) Draft a letter on behalf of Messrs Rahman and Khan, Katabon Market, Dhaka – 1100, placing an order to Dairy Products limited, Savar, Dhaka-1250, for 10,000 1 kg tins and 5,000 2 kg tins of powdered milk. Remind them they have agreed to allow 5% discount on the price quoted in the list. (10)
- (c) Write the phonetic transcription of the following words. (any five) (10)
- Mother, clear, education, diplomatic, gate, keep
7. (a) Briefly discuss the parts of a successful report. (10)
- (b) Write a short essay on **any one** of the following topics: (10)
- (i) Selfie Mania-Cool or Crazy?
- (ii) Reading Online Books and Newspapers
- (iii) My favourite city in the world
- (c) Write a dialogue between a countryman and a townsman, bringing out the comparative advantages of town and country life. (10)
8. (a) Transform the following sentence as directed. (any five) (10)
- (i) It was ten years ago and I was living in New York. (Simple)
- (ii) I saw a girl singing. (Complex)
- (iii) If you take exercise regularly, you can be fit. (Compound)
- (iv) Since I was experienced, they elected me director. (Simple)
- (v) He ran fast but missed the train. (Complex)
- (vi) Hearing a song, she woke up. (Compound)
- (b) In what way is a quotation letter different from a notice inviting tenders? (5)
- (c) Write short notes on any three of the following. (15)
- (i) Monophthongs (ii) Topic sentence of a paragraph (iii) Linkers (iv) Suffix and prefix
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **MATH 173** (Vector Analysis and Matrices)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Using vectors prove that the medians of a triangle meet in a point which is a point of trisection of the medians. (15)
- (b) Consider the vectors $\underline{a} = \underline{i} - 3\underline{j} + 2\underline{k}$, $\underline{b} = 2\underline{i} - 4\underline{j} - \underline{k}$, $\underline{c} = 3\underline{i} + 2\underline{j} - \underline{k}$.
- (i) Find the vector component of \underline{a} in the direction perpendicular to \underline{b} . (10)
- (ii) Determine whether the vectors \underline{a} , \underline{b} , \underline{c} are coplanar or not. (10)
2. (a) If $\underline{r} = xi + yj + zk$, then show that $\nabla \cdot \left[\frac{f(r)\underline{r}}{r} \right] = \frac{1}{r^2} \frac{d}{dr} (r^2 f(r))$ (12)
- (b) In what direction from the point (2, 1, -1) is the directional derivative of $\phi = x^2 yz^3$ a maximum? What is the magnitude of this maximum? (11)
- (c) Test whether $\underline{F} = xyz^2[(2x^2 + 8xy^2z)\underline{i} + (3x^3y - 3xy)\underline{j} - (4y^2z^2 + 2x^3z)\underline{k}]$ solenoidal. If so, find a \underline{V} such that $\underline{F} = \nabla \times \underline{V}$. (12)
3. (a) Evaluate $\int_C \underline{F} \times d\underline{r}$ for the vector function $\underline{F} = -yi + xj$ along the boundary (anti clockwise) of the region bounded by $y = x$ and $y^2 = 4x$. Also find the area of the enclosed region by using Green's theorem for plane. (17)
- (b) Evaluate $\iint_S \underline{A} \cdot \underline{n} dS$, where $\underline{A} = 18z \underline{i} - 12j + 3y \underline{k}$ and S is that part of the plane $2x + 3y + 6z = 12$ which is located in the first octant. (18)
4. (a) Show that $\underline{F} = 3x^2 yi + (x^3 + 2yz)\underline{j} + y^2 \underline{k}$ is a conservative force field. Find the scalar potential and use it to find the amount of work done in moving an object in this field from (1, -2, 1) to (3, 1, 4) (17)
- (b) State Gauss's Divergence theorem. Evaluate $\iint_S \underline{F} \cdot \underline{n} dS$ for the vector function $\underline{F} = 2x^2 yi - y^2 \underline{j} + 4xz^2 \underline{k}$ taken over the region in the first octant bounded by $y^2 + z^2 = 9$ and $x = 2$. (18)

Contd P/2

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SECTION – B

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

5. (a) If A and B be invertible matrices (with the same size). Show that (AB) is also invertible and $(AB)^{-1} = B^{-1} A^{-1}$. (10)

- (b) Find the inverse of the following matrix A by elementary row transformation (13)

$$A = \begin{bmatrix} 2 & 4 & 3 & 2 \\ 3 & 6 & 5 & 2 \\ 2 & 5 & 2 & -3 \\ 4 & 5 & 14 & 14 \end{bmatrix}$$

- (c) Solve the following system of linear equations by using Gaussian elimination: (12)

$$\begin{cases} x_1 + 3x_2 - 2x_3 + 5x_4 = 4 \\ 2x_1 + 8x_2 - x_3 + 9x_4 = 9 \\ 3x_1 + 5x_2 - 12x_3 + 17x_4 = 7 \end{cases}$$

- 6 (a) If A and B are symmetric matrices, prove that (AB) is symmetric if and only if A and B are commute. (10)

- (b) Reduce the following matrix into canonical form

$$A = \begin{bmatrix} 3 & 4 & 5 & 6 & 7 \\ 4 & 5 & 6 & 7 & 8 \\ 1 & 2 & 3 & 4 & 5 \\ 8 & 9 & 10 & 11 & 12 \\ 12 & 13 & 14 & 15 & 16 \end{bmatrix}. \text{ Hence, find its rank.} \quad (12)$$

- (c) Reduce the matrix $A = \begin{bmatrix} 1 & 3 & 6 & -1 \\ 1 & 4 & 5 & 1 \\ 1 & 5 & 4 & 3 \end{bmatrix}$ into two nonsingular matrices P and Q such

that $PAQ = \text{Normal form}$ and hence compute the rank. (13)

7. (a) Find the Eigen values and corresponding Eigen vectors of the matrix (20)

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -1 & 0 & 2 \\ 0 & 1 & 1 \end{bmatrix} \text{ and compute } A^7.$$

- (b) State Cayley-Hamilton theorem and use the theorem find the inverse of the matrix (15)

$$A = \begin{bmatrix} 3 & -1 & 1 \\ 7 & -5 & 1 \\ 6 & -6 & 2 \end{bmatrix}$$

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8. (a) Reduce the quadratic form $x_1^2 + 2x_2^2 - 3x_3^2 + 8x_1x_2 - 16x_3x_2 + 10x_1x_3$ to the canonical form and find rank, index and signature. Also write down the corresponding equations of transformation. (23)

- (b) Find the minimal polynomial of the matrix $A = \begin{bmatrix} 2 & 1 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 4 & 2 & 0 \\ 0 & 0 & 3 & 4 & 0 \\ 0 & 0 & 0 & 0 & 7 \end{bmatrix}$. (12)
-