CBCS SCHEME

USN | | | | | | | | | |

18CIV14/24

First/Second Semester B.E. Degree Examination, Jan./Feb. 2021
Elements of Civil Engineering and Mechanics

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions, choosing ONE full question from each module.***
2. Missing data, if any, may be suitably assumed.

Module-1

1 a. Explain briefly the scope of following areas of civil engineering :
i) Irrigation engineering
ii) Environmental engineering. **(10 Marks)**

b. What are the roles of civil engineers in the infrastructural development of a country? **(10 Marks)**

OR

2 a. State and explain basic idealization in mechanics. **(06 Marks)**

b. State and prove law of parallelogram of forces. **(06 Marks)**

c. Two forces acting on a body are 500N and 1000N as shown in Fig.Q2(c). Determine the third force F such that the resultant of all the three forces is 1000N, directed at 40° to the X axis.

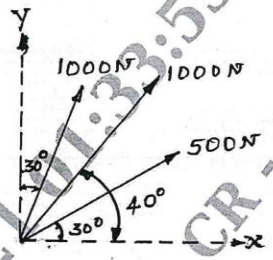


Fig.Q2(c) **(08 Marks)**

Module-2

3 a. State and prove Lami's theorem. **(08 Marks)**

b. Two identical cylinders, each weighing 500N are arranged in a through as shown in Fig.Q3(b). Determine the reactions developed at contact points A, B, C and D. Assume all points of contact are smooth.

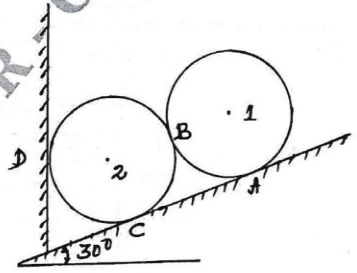


Fig.Q3(b) **(10 Marks)**

OR

4 a. State the laws of dry friction. **(04 Marks)**

b. Explain the types of friction. **(06 Marks)**

c. Find the force p just required to slide the block B in the arrangement shown in Fig.Q4(c). Find also the tension in the string. Given weight of block A = 500N and weight of block B = 1000N. $\mu = 0.2$ for all contact surfaces.

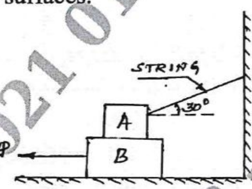


Fig.Q4(c) **(10 Marks)**

Module-3

5 a. Explain with sketches different types of loads. **(04 Marks)**

b. Explain with sketches different types of supports. **(06 Marks)**

c. Determine the reactions developed at supports A and B of overhanging beam shown in Fig.Q5(c).

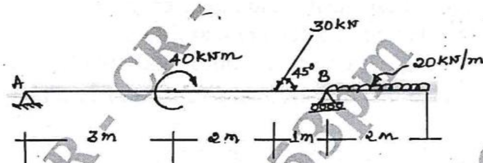


Fig.Q5(c) **(10 Marks)**

OR

6 a. List the different types of trusses. **(06 Marks)**

b. Analyse the truss shown in Fig.Q6(b) by method of joints.

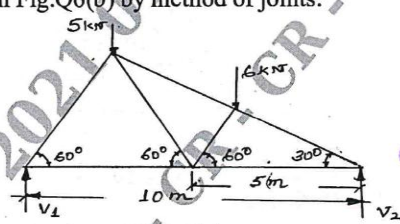
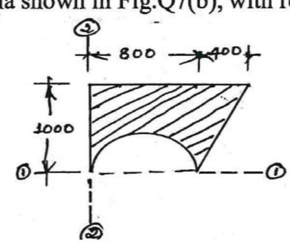


Fig.Q6(b) **(14 Marks)**

Module-4

7 a. Determine the centroid of a semicircular lamina from the first principle. **(08 Marks)**

b. Locate the centroid of the lamina shown in Fig.Q7(b), with respect to axes 1 – 1 and 2 – 2.



OR

8 a. State and prove parallel axes theorem. **(08 Marks)**

b. Determine the moment of inertia of the symmetric I-section shown in Fig.Q8(b) about its centroidal axes x-x ad y-y.

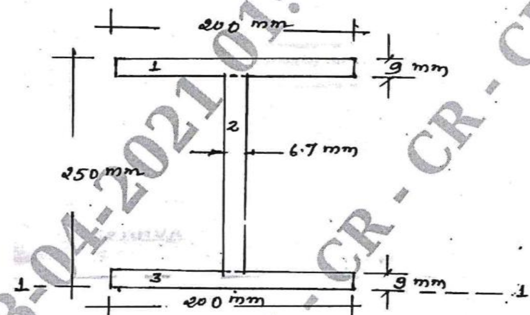


Fig.Q8(b) **(12 Marks)**

Module-5

9 a. Define the following :

i) Projectile
ii) Trajectory
iii) Time of flight
iv) Range. **(08 Marks)**

b. A projectile is fired at certain angle has a horizontal range of 3.5km. If the maximum height reached is 500m, what is the angle of elevation of the cannon? What was the muzzle velocity of the projectile? **(06 Marks)**

c. A Burglar's car starts with an acceleration of $2 m/sec^2$. A police van came after 10 sec and continued to chase the burglar's car with an uniform velocity of 40m/sec. find the time taken by the police van to overtake the Burglar's car. **(06 Marks)**

OR

10 a. State Newton's second law of motion and D'Alembert's principle. **(04 Marks)**

b. A lift carries a man of weight 4000kN and is moving with a uniform acceleration of $3.5 m/sec^2$. Determine the tension in the cable when :

i) Lift is moving upwards
ii) Lift is moving downwards. **(08 Marks)**

c. A car travelling at a speed of 75kmph applies brake and comes to a halt after skidding 60m. Determine :

i) Deceleration
ii) Time to stop the car
iii) Coefficient of friction between road and tyres. **(08 Marks)**

* * * * *

Answer:

1. a) i)

1.3.8 Scope of Irrigation

Irrigation may be defined as the process of supplying water to the soil for raising the crops by artificial means. Irrigation of land for agriculture represents one of oldest and most important uses of water, next to water provided for drinking and domestic purpose. It is a planned and designed science to fit the natural conditions, most suitably.

Irrigation is not just limited to application of water to soil but also watershed and agricultural farm. It deals with the design and construction of all works, such as dams, weirs, head regulators etc.

The scope of Irrigation engineering can be divided into two heads.

I) Engineering Aspect : This deals with :

1) Storage of water by constructing dam as reservoir.
2) Diversion of stored water to canals for distribution.
3) Lifting of water by digging wells and fed to small channels.
4) Conveyance of water to agricultural fields by some suitable distribution system like flooding, forrow, subsoil irrigation, sprinkler and drip irrigation.
5) Drainage and relieving the water logging, to maintain high productivity of canal.
6) Development of hydroelectric power.

II) Agricultural Aspect

1) Distribution of water uniformly and periodically to maintain proper depths of water for crops.
2) Capacities of different soils for irrigation water.
3) Reclamation of waste and alkaline lands.

Benefits of Irrigation

1) Increase in food production by applying scientific methods for optimum quantity of water to the crops.
2) Protection from famine as it maintains water supply during drought.
3) Cultivation of commercial or cash crops such as sugarcane, cotton etc.
4) Additional revenue to the nation in the form of water tax and bumper crops.
5) Living standards of people is improved with increase in land value and crop yield.
6) Generation of hydro-electric power and industrialization.
7) Improvement in ground water storage.
8) Helps in arboriculture.
9) India being an agricultural country, irrigation will definitely help in the overall development of our country, citizen and improve the civilization.

1. a) ii)

1.3.10 Environmental Engineering

Environmental Engineering is a multi-disciplinary science involving the application of engineering principles, the protection and enhancement of the quality of environment and to the enhancement and protection of public health and welfare.

The scope of the environmental education is to enlighten the public about :

1) The importance of protection and conservation of our environment.
2) The need to restrain human activities, which lead to indiscriminate release of pollutants into the environment.
3) The provision of safe, palatable and ample public water supply with water treatment facility.
4) Solution of problems of environmental sanitation with waste water treatment.
5) The proper disposal of or recycle of waste water and solid wastes.
6) Adequate drainage of urban, rural and recreational areas.
7) Control of water, soil and atmospheric pollution, and the social and environmental impact of these solutions.
8) Engineering problems in field of public health, such as control of water borne diseases.
9) Elimination of industrial health hazards.
10) The study of environmental impact assessment and mitigation measures.
11) Control of noise pollution.
12) Control of air-pollution.
13) Hazardous waste management and risk management with the mitigation measures.
14) To study environmental chemistry and biology, environmental hydrology & hydraulics, environmental quality modelling.
15) Recognize an ecosystem (inter-reaction between the living and non-living things in nature) and make scientific study of the interaction between the living and non-living components.

1. b)

1.4 Role of Civil Engineer in the Infrastructural Development

A Civil Engineer has to play a very important role by looking into the public needs through shelter, water supply for drinking and irrigation of crops, sewerage, transportation, energy and disaster protection, which forms the basic infrastructural demands of the society but keeping our social and cultural heritage.

The various jobs to be performed by a Civil Engineer are :

i) He takes up the construction sector job.

ii) He should be competent in the various fields of surveying, planning, analysing, designing, estimating, scheduling, execution, inspection and maintenance of work.

iii) He plans the buildings, towns, cities, recreational centres.

iv) He builds the structures like building, dam, bridges, reserviors, tunnels, railways, harbours etc.

v) He builds the water purifying units and distributes water for drinking purpose.

vi) He distributes the water for agricultural fields.

vii) He provides proper drainage treatments system and keep environment clean.

viii) He provides transport network through road, railways, harbours, port and docks, airports, tunnels, subways, overlays etc.

ix) He improves the ground water by providing rain water harvesting and water management techniques.

x) He sets the standards, design facilities and assess their conditions.

xi) He helps in maintaining the infrastructure at least practical cost.

xii) He can assist the policy makers to bring in society's interest to the changing technology and development.

xiii) The construction of Dams and Power Stations, that provide electricity we use everyday requires Civil Engineers.

xiv) A Civil Engineer can work all over the world, either as consultants with their own companies or as employees of large international companies; or as volunteers in developing countries.

xv) Civil Engineer plays vital role in the disaster management and rehabilitation.

xvi) Civil Engineer helps to preserve our environment by assisting in cleaning up of existing pollution and planning ways to reduce future pollution of our air, land and water as managing and mitigation measures.

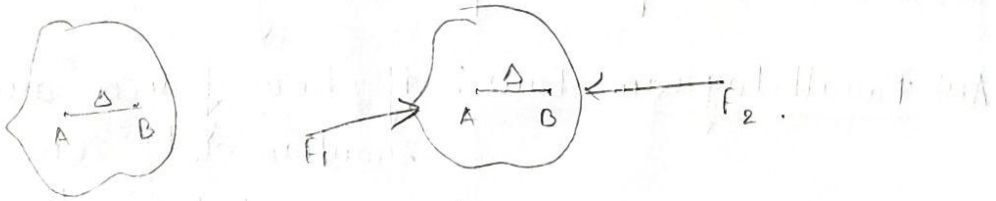
xvii) He should make use of his best experience in providing the optimum benefit to the public and government, which helps in further development of the infrastructure of the nation.

2a State and explain basic idealization in mechanics

Ans. Idealisations made in mechanics are:

i Particle: It is an object which has infinitely small volume and entire mass of the body is assumed to be concentrated at a point.

ii Rigid body: The body which does not alter its shape and size under the application of force.



From above figure we can observe that distance 'Δ' between the considered point A and B remains the same, even after the application of forces F_1 & F_2

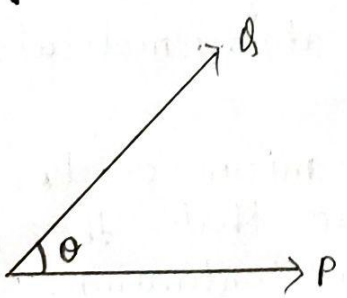
iii Continuum: These body are assumed to have continuous distribution of matter even though they are made up of atom, molecules.

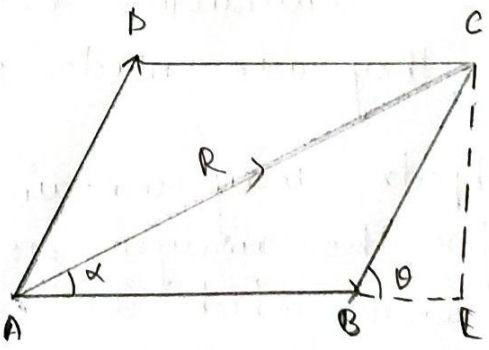
The objects may contain voids, micro. cracks, etc but for the analysis we assume that the matter is continuous which is known as continuum.

iv) Point force: The force acting on a body is assumed to be concentrated over a point even though there is certain area of contact. When we compare the magnitude of load with area of contact, the area of contact will be negligible. In such case it is assumed that force is concentrated over a single point, known as point force.

2b) State and prove parallelogram law of forces.

Ans) Parallelogram law: If two forces are acting simultaneously on a particle and away from the particle with the two adjacent sides of the parallelogram representing both magnitude and direction of force, the magnitude and direction of the resultant can be represented by the diagonal of the parallelogram starting from the common point of the two forces





Let P and Q be the two forces, representing sides AB and AD of the parallelogram. The resultant can be represented by the AC as shown

To find the magnitude of R of the resultant; consider the triangle ΔCAE where,

$$AC^2 = AE^2 + CE^2$$

$$AC^2 = (AB + BE)^2 + (CE)^2 \quad \text{——— i}$$

Again consider ΔCBF, where

$$CE = Q \sin\theta$$

$$BE = Q \cos\theta$$

Putting these values in equation i

$$AC^2 = AB^2 + 2AB \cdot BE + BE^2 + CE^2$$

$$R^2 = P^2 + 2PQ\cos\theta + Q^2\cos^2\theta + Q^2\sin\theta$$

$$R^2 = P^2 + Q^2 + 2PQ\cos\theta$$

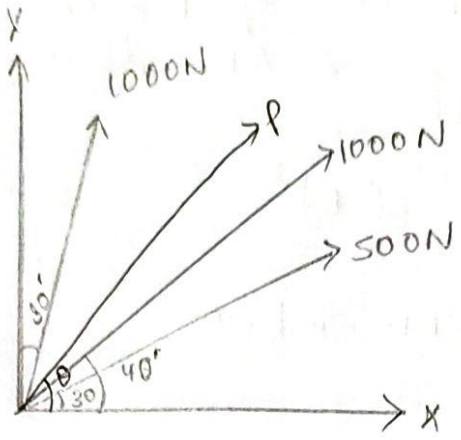
$$\boxed{R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}}$$

To find the direction of the resultant, consider the ΔCAE where,

$$\tan\alpha = \frac{CE}{AB + BE} = \frac{Q\sin\theta}{P + Q\cos\theta}$$

$$\boxed{\alpha = \tan^{-1}\frac{Q\sin\theta}{P + Q\cos\theta}} \quad \text{w.r.t } P$$

2c) Two forces acting on a body are 500N and 1000N as shown in fig, determine the third force F such that the resultant of all the three forces is 1000N, directed at 40° to the X axis.



Let's consider the force to be of magnitude P and direction θ with x-axis

Now, for body to be in equilibrium

$$\Sigma F_x = 0$$

$$1000 \sin 30 + P \cos\theta + 500 \cos 30 + 1000 \cos 40 = 0$$

$$P \cos\theta = -1699.057 \quad \text{——— i}$$

$$1000 \cdot \cos 30 + P \sin\theta + 500 \sin 30 + 1000 \sin 40 = 0$$

$$P \sin\theta = -1758.813 \quad \text{——— ii}$$

From equations i and ii / divide ii by i

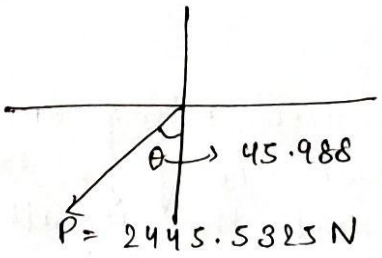
$$\tan\theta = 1.0351$$

$$\Rightarrow \boxed{\theta = 45.988}$$

from ii

$$P \sin\theta = -1758.813$$

$$\boxed{P = 2445.5325\ N}$$



3. a)

Lami's Theorem

Statement : "If three coplanar forces acting simultaneously at a point be in equilibrium, then each force is proportional to the Sine of the Angle between the other two forces".

Proof :

Figure (a) shows three coplanar concurrent forces P, Q, and R acting at point 0 in equilibrium.

Let α, β and γ be the corresponding opposite angles then, $\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$

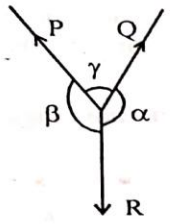


Fig. (a)

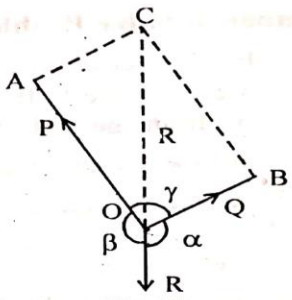


Fig. (b)

Construction : With P and Q as two forces along OA and OB, complete the parallelogram OACB as shown in fig. (b). Then the diagonal OC represent the resultant of P and Q according to the parallelogram law of forces. But, since the system is in equilibrium the resultant of force P and Q must be in line with OC but opposite to R.

From figure (b) in Δ OAC,

$$A\hat{O}C = 180 - \beta$$

$$A\hat{C}O = B\hat{O}C = 180 - \alpha$$

$$C\hat{A}O = 180 - A\hat{C}O - A\hat{O}C$$

$$= 180 - (180-\alpha) - (180-\beta)$$

$$= \alpha + \beta - 180 \quad \ldots\ldots\ldots\ldots (1)$$

We know that $\alpha + \beta + \gamma = 360^0$

Substracting both sides by 180^0

$$\alpha + \beta + \gamma - 180 = 360 - 180$$

$$\alpha + \beta - 180 = 180 - \gamma \quad \ldots\ldots\ldots\ldots (2)$$

$\therefore$ From (1) & (2)

$$C\hat{A}O = 180 - \gamma \quad \ldots\ldots\ldots\ldots (3)$$

Applying sine rule.

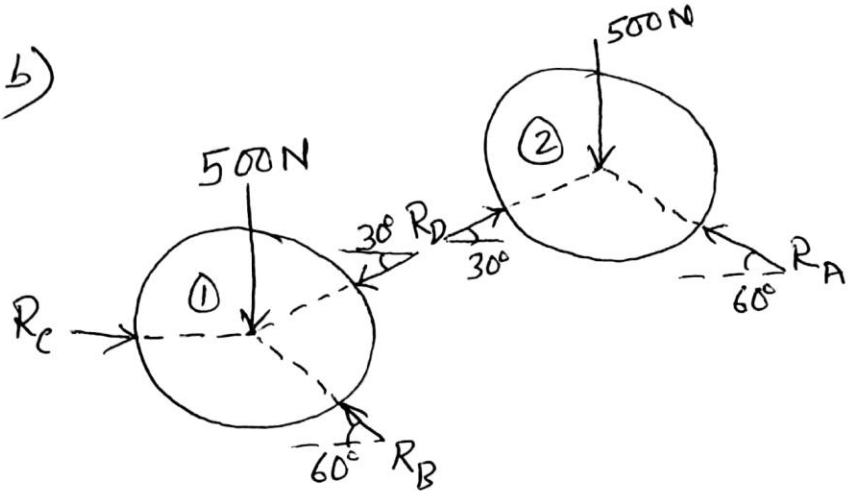
$$\frac{OA}{\sin A\hat{C}O} = \frac{AC}{\sin A\hat{O}C} = \frac{OC}{\sin C\hat{A}O}$$

$$\frac{P}{\sin(180-\alpha)} = \frac{Q}{\sin(180-\beta)} = \frac{R}{\sin(180-\gamma)}$$

OR $\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$ $\{\because \sin(180-\alpha) = \sin\alpha\}$

Hence proof.

3) b)



For cylinder ②

$$\frac{R_A}{\sin 120} = \frac{R_D}{\sin 150} = \frac{500}{\sin 90}$$

$\therefore R_A = 433.0127$ N

& $R_D = 250$ N

For Cylinder ①

$\Sigma V = 0$, Resolving the forces vertically, we have

$$R_B \sin 60 - R_D \sin 30 - 500 = 0$$

$$\therefore R_B = \frac{500 + 125}{\sin 60} = 721.6878 \text{ N}$$

$\Sigma H = 0$, Resolving the forces horizontally, we have,

$$R_C - R_D \cos 30 - R_B \cos 60 = 0$$

$\therefore R_C = 577.35$ N.

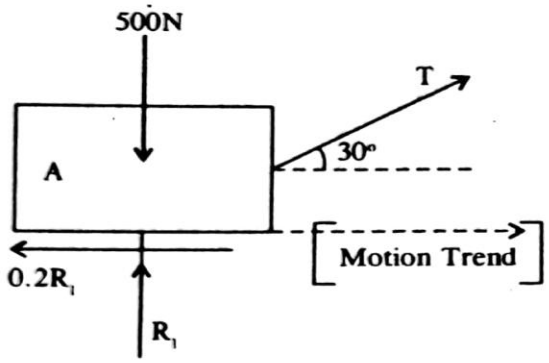
4. a)

4. b)

4. c)

Consider F.B.D of block A.

Tension 'T' tends the body the move towards right



FBD of block A

Resolving Forces Vertically, $\Sigma V = 0$

$$-500 + T\sin 30 + R_1 = 0 \qquad \text{.....(1)}$$

Resolving forces Horizontally, $\Sigma H = 0$

$$T\cos 30 - 0.2R_1 = 0$$

$$R_1 = \frac{T\cos 30}{0.2}$$

$$R_1 = 4.33T \qquad \text{.....(2)}$$

Substituting (2) in (1).

$$-500 + T\sin 30 + 4.33T = 0$$

$$-500 + 4.83T = 0$$

$$\therefore T = \frac{500}{4.83}$$

$$T = 103.52N \qquad \text{.....(3)}$$

From (2) and (3)

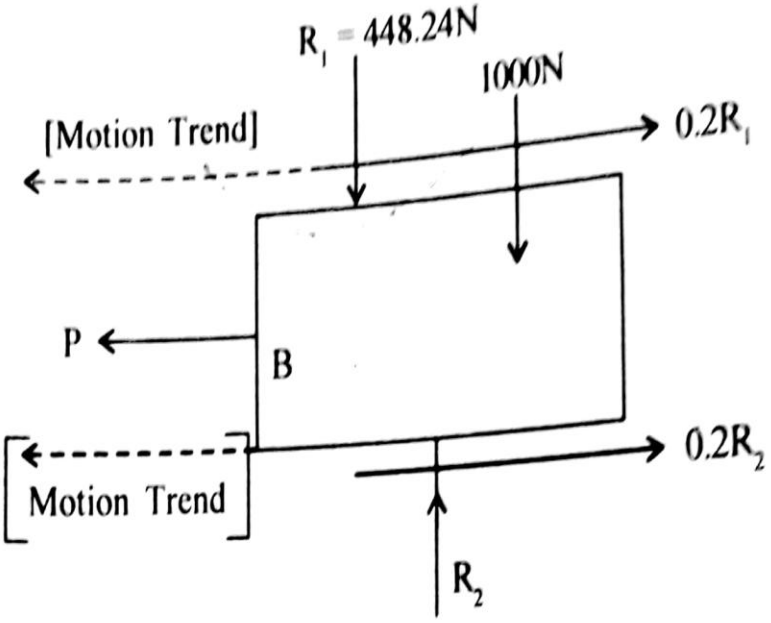
$$R_1 = 4.33T$$

$$= 4.33 \times 103.52$$

$$= 448.24N \qquad \text{.....(4)}$$

Consider FBD of Block B.

Block B is in contact at top and bottom



FBD of Block B

Resolving Forces Vertically, $\sum V = 0$

$$-448.24 - 1000 + R_2 = 0$$

$$R_2 = 1448.24N \quad \ldots (5)$$

Resolving forces Horizontally, $\sum H = 0$

$$-P + 0.2R_1 + 0.2R_2 = 0$$

$$-P + 0.2 \times 448.24 + 0.2 \times 1448.24 = 0$$

$$\therefore \quad P = 379.30N$$