CBCS SCHEME

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BESCK104A/BESCKA104

First Semester B.E./B.Tech. Degree Examination, Jan./Feb. 2023
Introduction to Civil Engineering

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Explain briefly civil engineering disciplines.	10	L1	CO1
	b.	List the qualities of good building stone.	10	L1	CO1
		OR			
Q.2	a.	Explain the following: (i) Reinforced Cement Concrete (RCC) (ii) Pre-Stressed Concrete (PSC) (iii) Construction Chemicals	10	L1	CO1
	b.	Explain different types of foundations, briefly.	10	L1	CO1
		Module – 2			
Q.3	a.	Explain concept of (i) Smart city (ii) Clean city	10	L1	CO2
	b.	Explain management of (i) Urban air pollution (ii) Solid waste	10	L1	CO2
		OR			
Q.4	a.	Explain: (i) Energy Efficient Buildings (ii) Temperature Control in Buildings	10	L1	CO2
	b.	Explain: (i) Security System (ii) Smart Buildings	10	L1	CO2
		Module – 3			
Q.5	a.	Explain classification of force system with neat sketches.	10	L1	CO3
	b.	Determine magnitude and direction of "P" for the system shown in Fig.Q5(b). Four coplanar forces acting at a point. One of the forces is unknown. The resultant has a magnitude of 500 N and is acting along x-axis.	10	L3	CO3

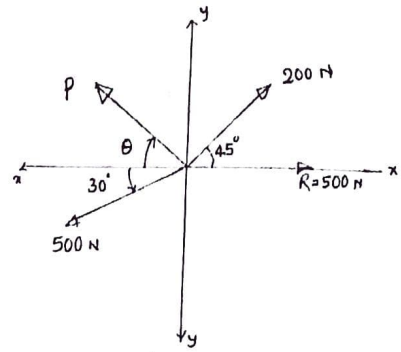

Fig.Q5(b)

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		OR			
Q.6	**a.**	State and prove Varignon's theorem of moments.	**10**	**L3**	**CO3**
	b.	Find the magnitude, direction and position of the resultant force with respect to point 'A' as shown in Fig.Q6(b).	**10**	**L3**	**CO3**

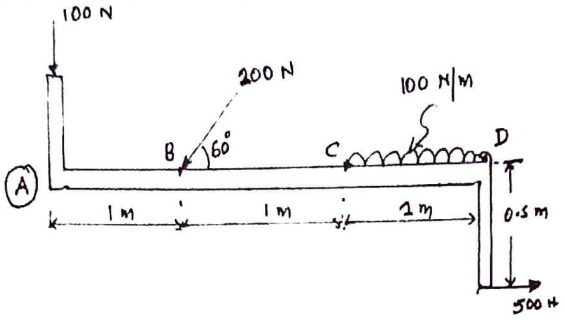

Fig.Q6(b)

		Module – 4			
Q.7	**a.**	Explain the following terms: (i) Centroid (ii) Axis of symmetry (iii) Axis of reference (iv) Centroidial axis (v) Centre of gravity	**10**	**L1**	**CO4**
	b.	Determine the centroid of the Fig.Q7(b) shown below:	**10**	**L1**	**CO4**

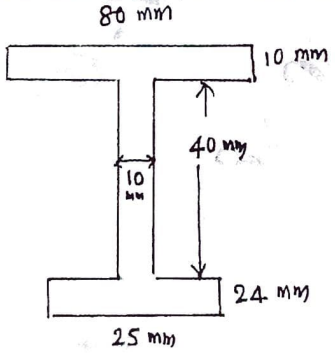

Fig.Q7(b)

		OR			
Q.8	**a.**	Prove that for a semicircle $\bar{Y} = \frac{4R}{3\pi}$.	**10**	**L1**	**CO4**
	b.	Determine the centroid of area shown in Fig.Q8(b).	**10**	**L1**	**CO4**

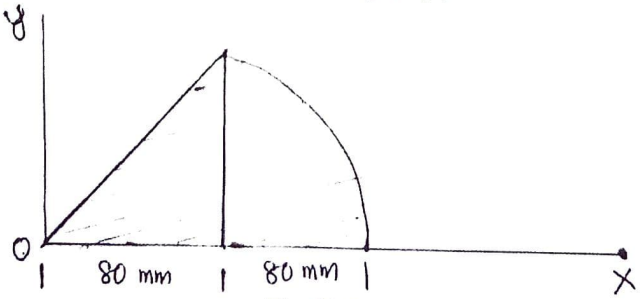

Fig.Q8(b)

Module – 5

Q.9	a.	State and prove parallel axis theorem.	10	L1	CO5
	b.	Determine moment of inertia about horizontal centroidal axis for the Fig.Q9(b)	10	L2	CO5

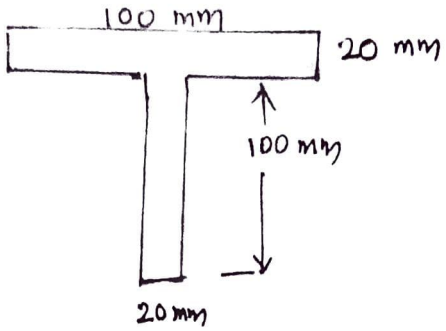

Fig.Q9(b)

OR

Q.10	a.	Derive the moment of inertia equation for a rectangle.	10	L1	CO5
	b.	Determine the moment of inertia of the section shown in Fig.Q10(b) with respect to horizontal to horizontal centroidal axis (Ixx).	10	L2	CO5

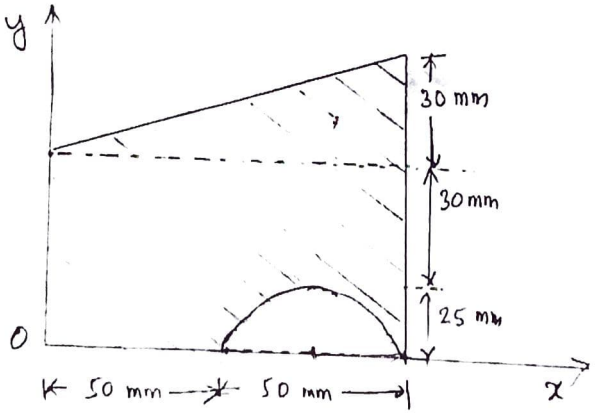

Fig.Q10(b)

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Jan | Feb · 2023

INTRODUCTION TO CIVIL ENGINEERING (BESCK104A)

Marks.

Q.1a. Explain briefly civil engineering disciplines.

→ *Structural engineering
*Geotechnical engineering
*Transportation engineering
*Environmental engineering
*Construction engineering
*Water resources and irrigation engineering

1. Structural engineering

Structural engineering is concerned with the analysis and design of various components of a structure for the possible forces that are coming on it. This involves identifying the loads which act upon a structure and the forces and stresses which arise within the structure due to those loads, and then designing the structure to successfully support and resist those loads. 5 x 2 = 10

2. Geotechnical engineering

All structures have to finally transfer the load acting on them to soil or earth safely. Hence, it becomes essential for a civil engineer to properly investigate soil and decide the safe load that can be spread on the soil.

3. Transportation engineering

For the growth of a nation, the transportation facility forms an important requirement. It is concerned with provision of safe & economic communication for.

the movement of people and goods.

4. Environmental engineering

Environmental engineering deals with the study of supply of potable water to the people, disposal of properly treated waste, & control of environmental pollution.

5. Construction engineering

Construction technology involves study on methods of construction and construction equipments that facilitate an efficient and economic construction processes.

6. Water resource & irrigation engineering

The requirement of water in cities for domestic purpose and for industries is continuously increasing. Rural areas also need water for agriculture.

1b. List the qualities of good building stone.

Qualities of good building stone.

*. Strength – the strength of the stone must able to resist the applying load or overcoming load.

* Durability – Stone must stay in all in all climatic conditions and resist all the natural destructive effects.

*. Appearance – The appearance of Stone must be aesthetic and could so that a requirement of polish and interesting not needed.

*. Hardness & toughness – It should be enough strong and hard to withstand all the stresses applied due to seismic forces, wind loads & a load of superstructure

Q2a. Explain the following

i) Reinforced Cement Concrete (Rcc)

ii) Pre-Stressed Concrete (psc)

iii) Construction Chemicals.

→ i) Reinforced Cement Concrete (Rcc)

Reinforced concrete, in which steel is embedded in such a manner that the two materials act together in resisting forces.

ii) Pre-Stressed Concrete (psc)

Prestressed concrete is a form of concrete used in construction. It is substantially "prestressed" (compressed) during production, in a manner that strengthens it against tensile forces which will exist when in service.

iii) Construction Chemicals.

Construction chemicals are chemicals formulations used with masonry materials, cement, concrete or other construction materials at the time of construction to hold the construction materials together. 10

Most construction chemicals are used as hardening agents either for surface application, coating or as repair materials and is also effective as a coater proofing chemical

Types of construction chemicals.

*. Concrete Hardeners

*. Protective & Decorative Coating

*. Concrete Curing

*. Epoxy Coating

*. Water Proofing Chemicals.

Q2b. Explain different types of foundations, briefly.

→ Different types of foundations used in constructions are:

i) Shallow foundation
*. Isolated footing
*. Combined footing
*. Strip foundation
*. Raft or mat foundation.

ii) Deep foundation.
*. Pile foundation
*. Drilled shafts.

* Isolated footing - It is the most common type of foundation used for building construction. This foundation is constructed for a single column and also called as pad foundation

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*. Combined footing - It is constructed when two or more columns are close enough & their isolated footings overlap each other.

* Strip footings. - Spread footings or Strip footings are those whose base is wider than a typical load-bearing wall foundations.

* Raft or Mat foundations - these are type of foundation which are spread across the entire area of the building to support heavy structural loads from columns & walls.

* Pile foundation - It is a type of deep foundation which is used to transfer heavy loads from the structure to a hard rock strata much deep below the ground level.

Q3a Explain Concept of (i) Smart City (ii) Clean City

→ i) Smart City - A Smart city is a technologically modern urban area that uses different types of electronic methods and sensors to collect specific data. Information gained from that data is used to manage assets, resources and services efficiently, in return, that data is used to improve operations across the city. This includes data collected from citizens, devices, buildings and assets that is processed and analyzed to monitor and manage traffic and transportation systems, Power plants, Utilities, water supply networks, information systems, hospitals & other community services

5 x 2 = 10

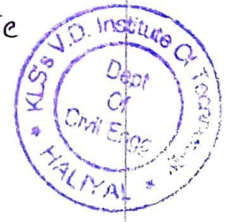
Q3b ii) Clean City - A city that is free from pollution and environment degradation. Both these terms are relatible in nature. A city that has many trees than buildings all over will be free from environmental problems as trees help to purify the air and maintain the cycle of nature.

When a city is kept free from pollution and virtuous it attracts the attention of tourists and visitors and earns a prominent place in the lives of its citizens.

Q3b. Explain management of i) Urban air pollution and ii) Solid waste.

→ i) Urban air pollution — Air quality management aims at the preservation of environmental quality by prescribing the tolerance degree of pollution, leaving it to the local authorities and polluters to devise and implement actions to ensure that this degree of pollution will not be exceeded. Urban air pollution management therefore, requires a multidisciplinary approach as well as joint effort by private and governmental entities.

ii) Solid Waste – Solid waste management, the collecting treating and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of environment and to outbreaks of disease. The tasks of solid-waste management present complex technical challenges. 5×2 = 10



Q4a. Explain (i) Energy Efficient Buildings and (ii) Temperature control in Buildings.

→ i) Energy efficient buildings – An energy efficient buildings offers an appropriate environment for habitation with minimal energy consumption and wastage of energy, thereby maximizing energy conservation.

Energy efficiency is the use of less energy in a building to perform the same operation as buildings that consumes energy inefficiently. It should be considered during the design stage, selection of construction materials, construction process, and operation of the building.

5 × 2 = 10

ii) Temperature control in buildings – It aids in maintaining steady heating and cooling temperatures during season changes throughout the year. Additionally, it helps to ensure quality and comfort among the occupants. Temperature control focuses on the transfer of heat within a building to either keep it cool or warm. To gain control, first, the ways heat can be transmitted must be identified.

Q4b. Explain (i) Security System (ii) Smart Buildings.

→ i) Security System — The building security and control system is designed to monitor and control mechanical & electrical installations, fire protection and escape, burglary, assault and emergency communication. In tall buildings and major complexes, the most important security requirement is fire-safety system. 5×2 = 10

ii) Smart Buildings — A smart building is any structure that uses automated processes to automatically control the building's operations including heating, ventilation, air conditioning, lighting, security and other systems, maximizing user comfort while minimizing energy consumption.

Q5a. Explain classification of force system with neat sketches

→ *. Collinear forces — Lines of action of all the forces act along the same line.

*. Coplanar parallel forces — All forces are parallel to each other and lie on a single plane.

*. Coplanar Concurrent forces — Lines of action of all force pass through a single point and forces lie on the same plane.

*. Coplanar non-concurrent forces — All forces do not meet at a point, but lie on a single plane.

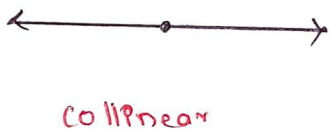
Q.No. | Marks

Q5a. Explain classification of force system with neat sketches.

→ *. Non-Coplanar Parallel forces — All the forces are parallel to each other, but not in same plane

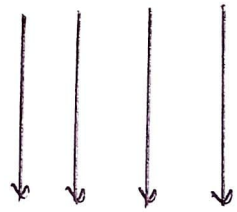
*. Non-coplanar concurrent forces — All forces do not lie on the same plane but their lines of action pass through a single point.

*. Non-coplanar non concurrent forces — All forces do not lie on the same plane, but their lines of action do not pass through a single point.

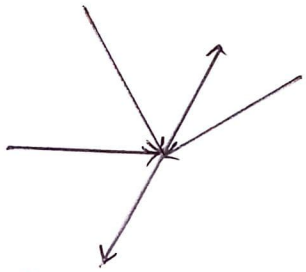


Collinear

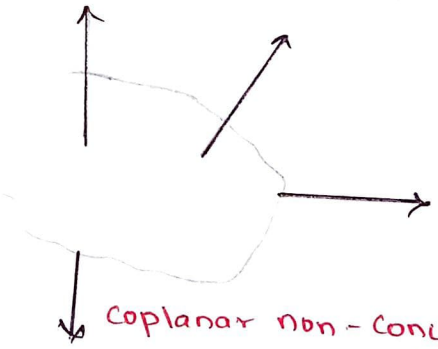
Coplanar Parallel



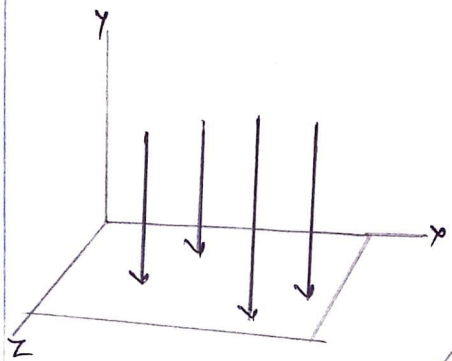
Coplanar like parallel



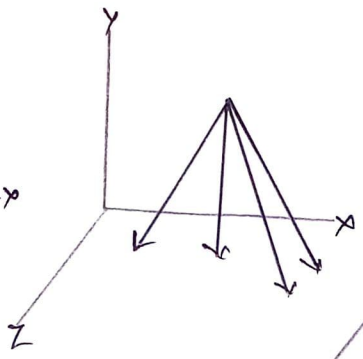
Coplanar concurrent



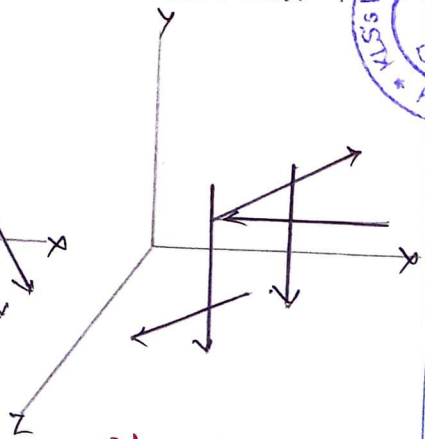
Coplanar non-Concurrent



Non-Coplanar Parallel



Non-Coplanar Concurrent



Non-Coplanar non-Concurrent

10

Q.No.		Marks
5 b)	Numerical on composition of coplanar Concurrent forces.	
Sol^n:	Given $R = 500\,N$ and is along x-axis.	
	$\Rightarrow \Sigma F_x = 500\,N$ & $\Sigma F_y = 0$ ----	01M
	$\Rightarrow +200\sin 45 + P\sin\theta - 500\sin 30 = 0$	
	$\Rightarrow P\sin\theta = 108.57$ ---- (1) ----	03M
	$P^2\sin^2\theta = 11787.44$	
	Also, $200\cos 45 - P\cos\theta - 500\cos 30 = 500$	
	$\Rightarrow P\cos\theta = 200\cos 45 - 500\cos 30 - 500$	
	$P\cos\theta = -791.59$ ---- (2) ----	03
	$P^2\cos^2\theta = 791.59^2$	
	(1) ÷ (2)	
	$\frac{P\sin\theta}{P\cos\theta} = \frac{108.57}{-791.59}$	
	$\Rightarrow \tan\theta = -0.137$	
	$\Rightarrow \theta = \tan^{-1} 0.137$	
	$180 - \theta = 172.19^\circ \Rightarrow \theta = 7.81^\circ$	
	Sub in (1) or (2) ----	03
	$P = 799.00\,N$	Total 10M

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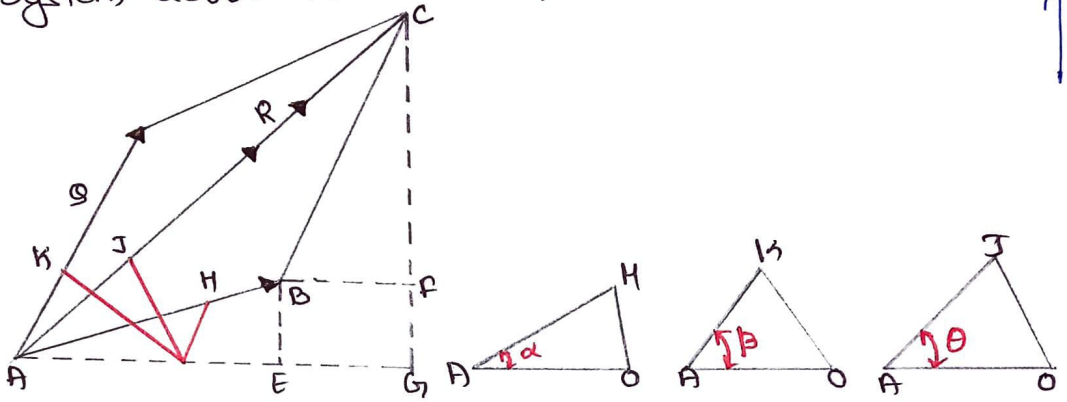
Q6a. State and Prove Varignon's theorem of moments.

→ "The moment of resultant of a force system about any point is equal to the algebraic sum of the moments of all the forces of the force system about the same point". 02



01

Two coplanar concurrent forces P & Q acting at a point A, the resultant of which is R. According to the Varignon's theorem

$$M_O^R = M_O^P + M_O^Q = \Sigma M_O .$$ 02

where,

M_O^R = moment of resultant R about O, M_O^P = moment of force P about O, M_O^Q = moment of force Q about O & ΣM_O = algebraic sum of moment of all forces @ O.

From right hand side $\Sigma M_O = M_O^P + M_O^Q$

$= P(OA\sin\alpha) + Q(OA\sin\beta)$

$= OA \times (P\sin\alpha + Q\sin\beta)$ 02

From triangle ABE, $P\sin\alpha = BE$ & from triangle CBF, $Q\sin\beta = CF$

$\therefore \Sigma M_O = OA \times (BE + CF) = OA \times (FG + CF)$

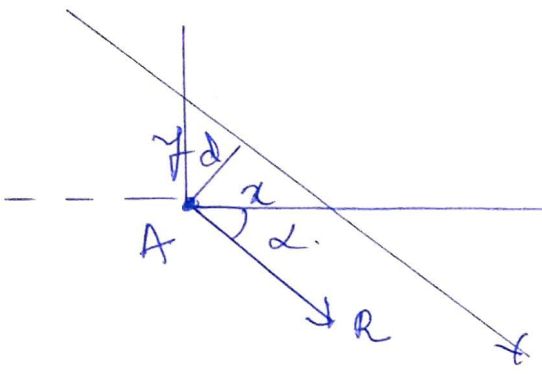
$= OA \times CG$

In Δ^{le} ACE, $CG = R\sin\theta$, hence 03

$$\Sigma M_O = OA \times (R\sin\theta) = R \times (OA\sin\theta)$$

$$\Sigma M_O = M_R^O .$$

10

Q.No.		Marks
6 b)	Numerical problem on composition of Coplanar non concurrent forces.	
	$\Sigma F_x = -200\cos 60 + 500 = +400\ N$ - - - - -	02M
	$\Sigma F_y = -100 - 200\sin 60 - 100 = -373.21\ N$ - - -	02M.
	$R = \sqrt{400^2 + (-373.2)^2} = 547.06\ N$	
	$\alpha = \tan^{-1}\frac{373.21}{400} = 2.54^\circ$ - - -	01
	$\Sigma M_A = +200\sin 60 \times 1 + 100 \times 2.5 - 500 \times 0.5 = 173.20\ N.m$ - - -	03
	$d = \frac{\Sigma M}{R} = \frac{173.20}{547.06} = 0.32m$	
	$x = \frac{\Sigma M}{\Sigma F_y} = \frac{173.20}{373.21} = 0.46m$	01
	$y = \frac{\Sigma M}{\Sigma F_x} = \frac{173.20}{400} = 0.433m$	
	 - - - - - - -	01
	Total	10M.

9Ta. Explain the following terms :
i) Centroid (ii) Axis of Symmetry (iii) Axis of reference
iv) Centroidal axis (v) centre of gravity.

→ i) Centroid – The plane figures (like triangle, quadrilateral, circle, trapezoid etc) have only areas but no mass. The centre of area of such figures is known as centroid. It is also called the geometrical centre or the centre of gravity

ii) Axis of Symmetry. – Axis of Symmetry is a line or axis which divides the given line, area or volume into two equal and identical parts. Centroid always lies along the line of axis of Symmetry.

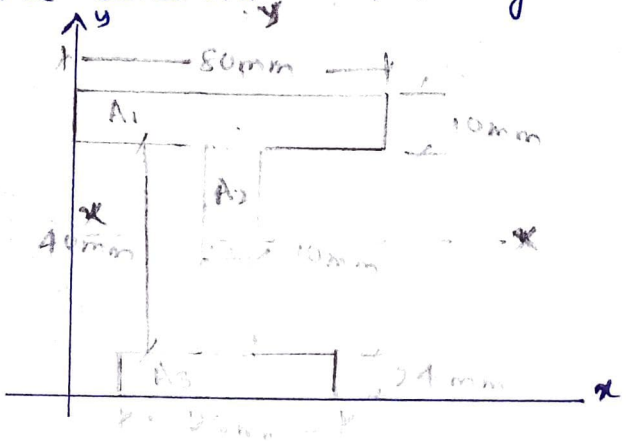
iii) Axis of reference – An axis of reference is a reference line from which distance of all objects are measured to describe their respective locations or points.

5 x 2 = 10

iv) Centroidal axis – The centroidal axis is an imagina-ry line passing through the centroid of an element.

v) Centre of gravity – Centre of gravity (C.g) is that point through which the resultant of a system of parallel forces formed by the weights of all particles of the body passes.

Q.7) b) Determine centroid of the fig. Q.7(b) shown below



Sol:- Area of Built up section is divided into three area of rectangles. A_1, A_2 & A_3.

$A_1 = 10 \times 80 = 800\ mm^2$ $(b_1 \times d_1)$

$A_2 = 10 \times 40 = 400\ mm^2$ $(b_2 \times d_2)$

$A_3 = 25 \times 24 = 600\ mm^2$. $(b_3 \times d_3)$

Centroidal distance from x-axis (y)

$y_1 = 24 + 40 + \frac{d_1}{2}$

$= 69\ mm$

$y_2 = 24 + \frac{40}{2} \rightarrow d_2$

$= 44\ mm$

$y_3 = \frac{24}{2} \rightarrow d_3 = 12\ mm$.

10

$\Sigma A_i y_i = 55200 + 17600 + 7200$

$= ((A_1 \times y_1) + (A_2 y_2) + A_3 y_3))$

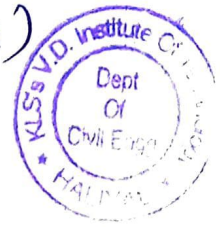
$= 80,000\ mm^3$

$\Sigma A_i = A_1 + A_2 + A_3 = 1800\ mm^2$

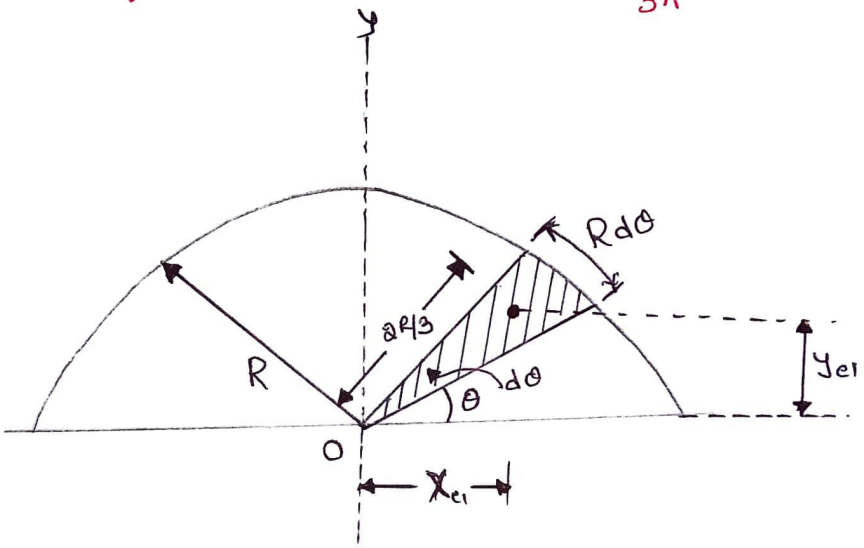
$\Rightarrow \bar{y} = \frac{\Sigma A_i y_i}{\Sigma A_i} = \frac{\Sigma A_i y_i}{A} = \frac{80000}{1800} = 44.44\ mm$

Since the built up section is symmetric about y axis. $\bar{x} = \frac{80}{2} = 40\,mm$

$\therefore (\bar{x}, \bar{y}) = (40, 44.44)$



Q8a. Prove that for a Semicircle $\bar{y} = \frac{4R}{3\pi}$



02

The Centroidal coordinates of a Semicircle are obtained by limit of integration of θ is from 0 to π.

$$\bar{x} = \frac{\int x\,dA}{\int dA} = \frac{\int_0^{\pi} \frac{R^3}{3}\cos\theta \cdot d\theta}{\int_0^{\pi} \frac{R^2}{2}\,d\theta} = \frac{\frac{R^3}{3}\left[\sin\theta\right]_0^{\pi}}{\frac{R^2}{2}\left[\theta\right]_0^{\pi}}$$

03

$$\bar{x} = 0 \quad \text{---------- (1)}$$

This indicates that the Centroid lies on y-axis

$$\therefore \bar{y} = \frac{\int y\,dA}{\int dA} = \frac{\int_0^{\pi} R^3/3 \sin\theta \cdot d\theta}{\int_0^{\pi} \frac{R^2}{2}\,d\theta}$$

02

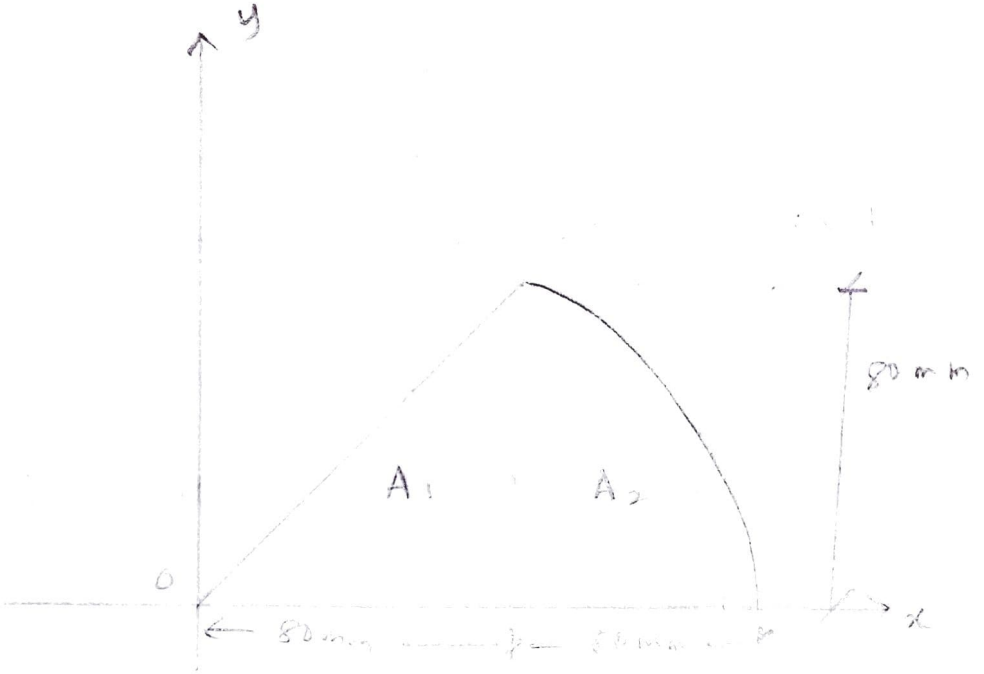
$$\bar{y} = \frac{\frac{R^3}{3}\left[-\cos\theta\right]_0^{\pi}}{\frac{R^2}{2}\left[\theta\right]_0^{\pi}} = \frac{2R}{3}\,\frac{-(\cos\pi - \cos 0^\circ)}{\pi}$$

03

$$\boxed{\bar{y} = \frac{4R}{3\pi}}$$

10

Q. 8) b) Determine centroid of area shown in fig Q.8b.



Sol?:- The built area is divided into two simple areas A_1 & A_2. 10

A_1 is a Δ^{le} & A_2 is Quarter of a O^{le}.

$$A_1 = \frac{1}{2} \times b \times h = \frac{1}{2} \times 80 \times 80 = 3200 mm^2$$

$$A_2 = \frac{\pi d^2}{16} = \frac{\pi R^2}{4} = \frac{\pi \times 80^2}{4} = 5026.548 mm^2$$

$$x_1 = \frac{2}{3} \times b = \frac{2}{3} \times 80 = 53.33 mm, \text{ from } y\text{-axis}$$

$$y_1 = \frac{1}{3} \times h = \frac{1}{3} \times 80 = 26.67 \text{ from } x\text{-axis}$$

$$x_2 = 80 + \left(\frac{4R}{3\pi}\right) = 80 + \frac{4 \times 80}{3\pi} = 113.953 mm$$

$$y_2 = \frac{4R}{3\pi} = \frac{4 \times 80}{3 \times \pi} = 33.953 mm$$

$$\Sigma A_i = A = 3200 + 5026.548 = 8226.548 mm^2$$

$$\Sigma A_i y_i = \frac{85,334.4 + 170\,666.384}{8226.548}$$

$$= 90.373 \text{ mm}.$$

$$\Sigma A_i x_i = \frac{170,665.6 + 572,790.224}{8226.548}$$

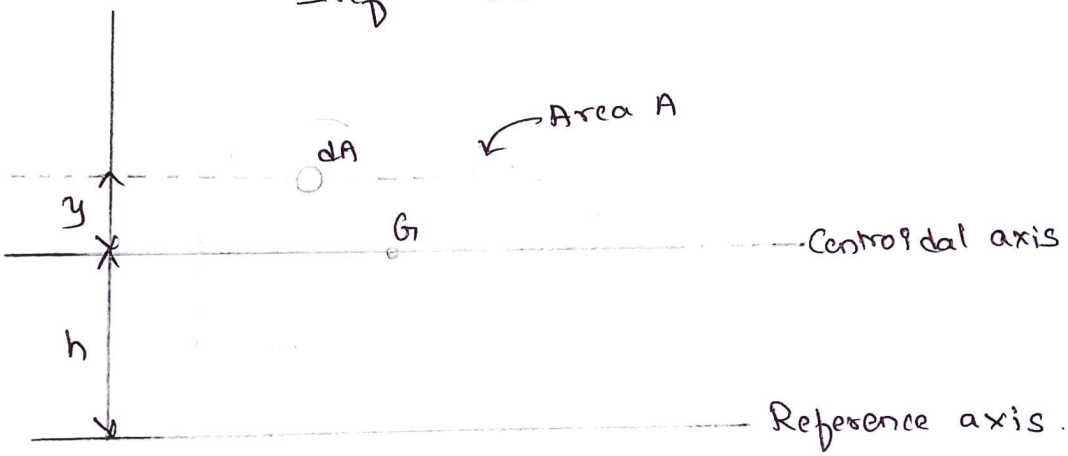
$$= 31.119 \text{ mm}.$$

$$(\bar{x}, \bar{y}) = (90.373, 31.119)$$

Q9a. State and Prove Parallel axis theorem

→ "Moment of inertia of an area about any reference axis (I_{ref}) is equal to the sum of moment of inertia of the same area about its centroidal axis (I_{cent}) parallel to reference axis and the product of area (A) and the square of the distance (h) between the reference and centroidal axes"

$$I_{ref} = I_{cent} + Ah^2$$



05

An axis passing through the centroid G of an area is called centroidal axis. The theorem can be proved as:

The moment of inertia of an area about a given reference axis is.

$$I_{ref} = \int (h+y)^2 dA$$

$$(h+y)^2 = h^2 + 2hy + y^2$$

$$\therefore I_{ref} = \int h^2 dA + \int 2hy dA + \int y^2 dA$$

$$I_{ref} = h^2 \int dA + 2h \int y.dA + \int y^2 dA$$

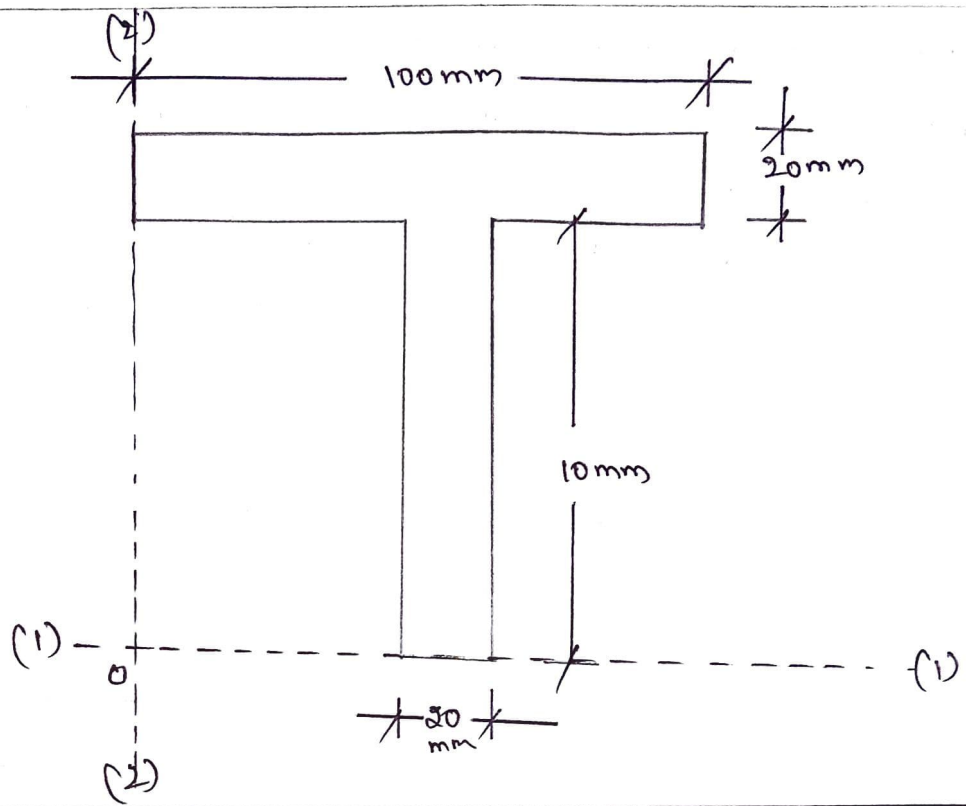
05

In the above expression $\int y^2 dA = I_{cent}$, $\int dA = A$ & $\int y dA =$ first moment of area about centroidal axis. which is equal to zero.

10

$$\therefore \boxed{I_{ref} = h^2 A + I_{cent}} \text{ (or) } \boxed{I_{ref} = I_{cent} + Ah^2}$$

Q9.b.



Components	Area "a" mm^2	Dist. of centroid from (1)-(1) "y" mm	Moment of area about (1)(1) "ay" mm^3	Moment of area about (1)-(1) "ay^2" mm^4	I_{gx} mm^4
g_1 □le	$= 20 \times 100$ $= 2000$	$\frac{100}{2} = 50$	100000	5000000	$\frac{bd^3}{12} = \frac{20 \times 100^3}{12}$ $= 1666666.66$
g_2 □le	$= 100 \times 20$ $= 2000$	$= 100 + \frac{20}{2}$ $= 110$	220000	24200000	$bd^3/12$ $= 66666.66$
	$\Sigma a = 4000$		$\Sigma ay = 320000$	$\Sigma ay^2 = 29200000$	ΣI_{gx} 1733333.32

05

$$\bar{y} = \frac{\Sigma ay}{\Sigma a} = \frac{320000}{4000} = 80 \text{ mm}$$

$$I_{1-1} = \Sigma I_{gx} + \Sigma ay^2$$

$$= 1733333.32 + 29200000$$

$$I_{1-1} = 30933333.32 \text{ mm}^4$$

05

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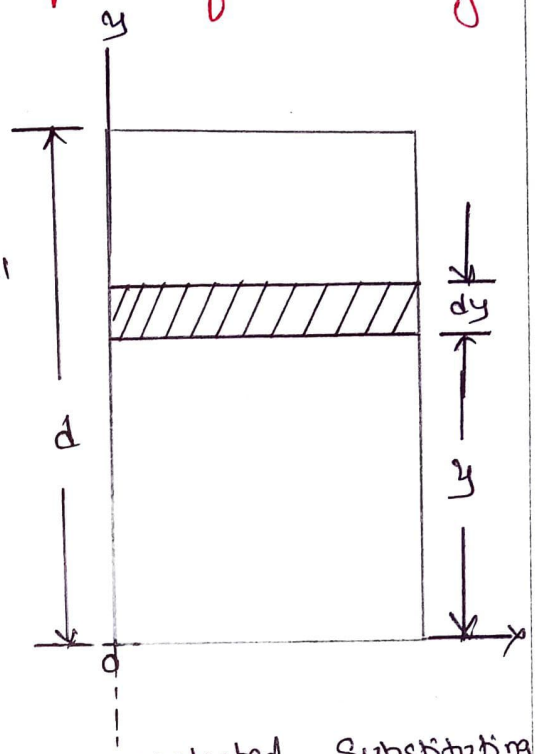
Q10a. Derive the moment of inertia equation for a rectangle.

→ Consider an elemental strip of width "b" and thickness "dy" in a rectangular area. Area of the element and its centroidal coordinates from x and y axes are given as



$$dA = b \times dy$$

$$x = \frac{b}{2}$$

$$y = y + \frac{dy}{2}$$

01

Here $dy/2$ is very small and hence neglected. Substituting these values in the equation. $I_x = \int y^2 dA$, the moment of inertia of rectangular about x-axis is determined as.

05

$$I_x = \int y^2 dA = \int y^2 . b . dA$$

Integrating between the limits of y from 0 to d, yields

$$I_x = \int_0^d b y^2 . dA = \frac{bd^3}{3}$$

$$\boxed{I_x = \frac{1}{3} bd^3}$$

02

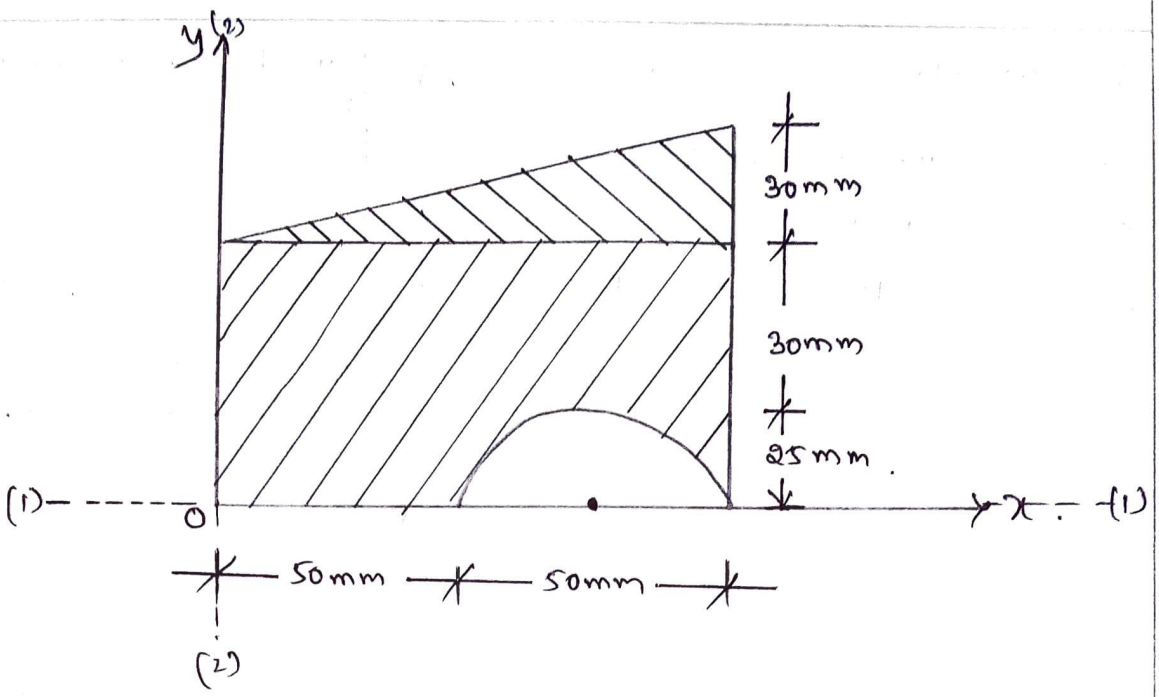
Similarly, moment of inertia of rectangular about y axis is

$$\boxed{I_y = 1/3\ bd^3}$$

02

10

Q10.b



Components	Area "a" mm^2	Dist. of Centroid from (1)(1) "y" mm	Moment of area about (1)-(1) "ay" mm^3	moment of area about (1)-(1) "ay^2" mm^4	I_{gx} mm^4
g_1 (Δ^{le})	$\frac{1}{2} \times 100 \times 30$ = 1500	$55 + \frac{30}{3}$ = 65	1500 × 65 = 97500	1500 × $(65)^2$ = 6337500	$\frac{bb^3}{36}$ = 75000
g_2 ($\square^{le}$)	100 × 55 = 5500	$\frac{55}{2}$ = 27.5	5500 × 27.5 = 151250	5500 × $(27.5)^2$ = 4159375	$bd^3/12$ = 1386458.33
Deduction					
g_3 (Semi O'le)	$\frac{\pi (25)^2}{2}$ = 981.74	0.424 × 25 = 10.6	10406.44	110308.30	$0.11r^4$ 42968.75
	Σa = 6018.73		Σay = 238343.56	Σay^2 10386566.7	ΣI_{gx} 1418489.5

05

$\bar{y} = \frac{\Sigma ay}{\Sigma a} = 39.60 mm$

$I_{1-1} = \Sigma I_{gx} + \Sigma ay^2$

$= 1418489.58 + 10386566.7$

$= 11805056.28 \ mm^4$

$I_{1-1} = I_{xx} + Ay^2$

$\therefore I_{xx} = I_{1-1} - Ag^2$

$= 11805056.28 - 6018 (39.6)^2$

$I_{xx} = 2366724.64 \ mm^4$

05

10.