|| Jai Sri Gurudev ||

S J C Institute of Technology, Chickballapur

Department of Civil Engineering

CO-PO and CO-PSO Mapping

Name of the staff(s): Dr. G V Sharmila and Mr. Sathish Y A

Subject : Elements of Civil Engineering and Mechanics **Sub code : 18CIV14/24**

Semester : I

Course Objectives:

The Objectives of this course are:

- To make students to learn Scope of various fields of Civil Engineering, basics of civil engineering concepts and importance of Infrastructure development.
- To develop a student's ability to analyse the problems involving Forces and Moments with their applications, Centroid and Moment of Inertia, Kinematics and Kinetics of bodies

Course Outcomes:

At the end of the course students should be able to

CO1	Outline the scope of different fields of civil engineering and role of civil engineer in the infrastructure development.
CO2	Identify the resultant of coplanar force system and frictional force.
CO3	Analyze the statically determinate beams and trusses.
CO4	Identify the Centroid and moment of inertia of built-up sections.
CO5	Define the characteristics of motion of bodies and analyze the bodies in motion.

Programme Specific Outcomes (PSO's)

After Successful completion of B.E programme in Civil Engineering, the students will be able to:

PSO1: Demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering structures, along with good foundation in mathematics, basic sciences and technical aspects.

PSO2: Inculcating communicational skills and leadership attributes towards the team work. Developing critical thinking abilities with competence in modern tool usage.

CO-PO Mapping													CO-PSO Mapping	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1									1				
CO2	3	2								1			2	
CO3	3	3								1			2	
CO4	3	2								1			2	
CO5	3	2								1			2	
Avg	3.0	2.25								1				

1: Slightly 2: Moderately 3: Substantially

Signature of the Staff

Signature of the Reviewer

Course Outcomes

CO1	Outline the scope of different fields of civil engineering and role of civil engineer in the infrastructure development.
CO2	Identify the resultant of coplanar force system and frictional force.
CO3	Analyse the statically determinate beams and trusses.
CO4	Identify the centroid and moment of inertia of built up sections.
CO5	Define the characteristics of motion of bodies and analyse the bodies in motion.

Program Outcomes

PO1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	Problem analysis	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes

PSO1	Demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering structures, along with good foundation in mathematics, basic sciences and technical aspects.
PSO2	Inculcating communicational skills and leadership attributes towards the team work. Developing critical thinking abilities with competence in modern tool usage.

CO-PO & CO-PSO Attainment

Department		Civil Engineering	Test - I						Test - II						Test - III												Assignment Marks	End Term	
Program		B E	Q1 or Q2	Q3 or Q4		Q5 or Q6	Q7 or Q8	Q9 or Q10	Q1 or Q2	Q3 or Q4		Q5 or Q6	Q7 or Q8	Q9 or Q10	Q1 or Q2			Q3 or Q4			Q5 or Q6		Q7 or Q8		Q9 or Q10				Final IA Marks	University Marks
Course		Elements of Civil Engg. & Mechanics																											
Date		September 2019 to January 2020	CO1	CO2	CO2	CO2	CO2	CO2	CO2	CO2	CO3	CO2	CO2	CO3	CO1	CO2	CO2	CO2	CO2	CO2	CO3	CO3	CO4	CO4	CO5	CO5	CO5			
Sl. No.	USN	Name of the Student	10 Marks	6 Marks	4 Marks	10 Marks	10 Marks	10 Marks	10 Marks	4 Marks	6 Marks	10 Marks	10 Marks	10 Marks	8 Marks	4 Marks	8 Marks	4 Marks	6 Marks	10 Marks	8 Marks	12 Marks	8 Marks	12 Marks	6 Marks	6 Marks	8 Marks	10 Marks	40 Marks	60 Marks
1	1SJ19IS001	ABHIKUMAR R	4	1	0	0	3	1	0	0	0	0	1	0	4	0	3	0	0	0	6	0	0	0	6	6	8	10	17	15
2	1SJ19IS002	ADARSH K R	6	1	2	0	6	3	10	2	6	4	2	2	6	4	2	0	0	0	0	0	8	0	6	6	6	10	28	29
3	1SJ19IS003	ADDULA SWETHA	6	2	6	9	6	4	10	0	6	0	1	6	6	4	0	4	6	0	8	6	0	0	2	1	0	10	31	24
4	1SJ19IS004	AKASH D R	6	0	0	9	10	0	0	3	6	4	5	3	3	0	4	0	0	3	2	3	0	6	0	0	0	9	21	13
5	1SJ19IS005	AKASH N	8	5	0	7	5	0	0	0	4	2	10	8	8	0	4	0	3	6	6	2	8	0	0	0	0	10	25	21
6	1SJ19IS006	AKASH R	7	5	0	10	8	0	10	1	0	5	10	6	8	0	4	0	6	7	6	0	8	5	0	0	0	10	28	23
7	1SJ19IS008	ANDE NAGASHRI	9	5	0	5	10	10	10	2	5	3	2	10	8	4	7	4	5	9	6	12	2	8	6	6	0	9	31	26
8	1SJ19IS009	ANKUSHA J R	8	3	4	6	10	7	10	4	6	10	7	10	7	4	7	2	6	8	6	8	8	12	6	6	6	10	36	45
9	1SJ19IS010	ANUSHA G	10	6	4	10	10	10	10	4	6	10	10	10	8	4	8	4	6	9	8	11	8	12	6	6	8	10	40	32
10	1SJ19IS011	ARCHANA R	6	1	10	10	9	5	0	4	6	0	0	4	6	2	6	4	6	0	8	12	0	0	6	0	0	10	34	25
11	1SJ19IS012	B KIRAN	10	2	7	6	2	6	6	2	6	6	8	7	6	2	6	0	0	0	8	0	8	0	6	6	6	10	28	8
12	1SJ19IS013	BALAGUNDLA ANVESH	7	5	0	8	3	4	0	0	2	1	1	0	8	4	1	4	5	0	3	1	6	2	6	4	0	10	20	25
13	1SJ19IS016	BHVANI D	7	2	8	10	6	10	4	4	6	0	8	8	8	4	6	4	6	10	8	0	8	12	2	2	2	10	27	12
14	1SJ19IS017	BHOOMIKA R	5	1	1	7	2	4	0	4	3	9	2	2	6	2	1	1	3	0	8	4	5	2	2	0	1	10	21	14
15	1SJ19IS019	CHANDAN G M	3	4	0	9	9	0	0	0	0	0	0	4	8	4	4	0	0	0	0	12	0	0	0	0	0	10	19	12
16	1SJ19IS020	CHANDAN K J	10	6	3	10	10	5	10	4	6	10	10	10	8	4	8	2	5	7	8	10	8	9	6	5	8	10	38	30
17	1SJ19IS021	CHANDAN R	9	5	1	10	8	0	8	3	5	2	4	2	8	4	8	2	6	4	8	12	0	0	6	6	5	10	29	38
18	1SJ19IS022	CHANDANA S	10	0	9	10	0	10	10	0	6	3	0	6	6	4	2	2	2	6	6	0	6	6	6	2	2	10	28	21
19	1SJ19IS023	CHARANYA P M	10	2	10	10	7	10	10	0	0	6	0	6	6	4	0	4	6	6	8	12	0	0	6	0	0	10	36	32
20	1SJ19IS024	CHARITHA REDDY V	6	0	0	8	6	0	4	0	6	0	3	4	8	0	6	0	4	0	0	10	8	5	1	0	4	9	21	21
21	1SJ19IS025	CHETHANA C	10	5	0	10	10	0	10	4	6	0	10	5	8	2	8	2	6	10	8	7	8	8	6	5	7	10	33	32
22	1SJ19IS026	CHETHANA S	10	6	3	10	10	7	10	4	6	5	6	10	7	4	8	0	0	6	7	8	8	8	6	4	0	9	33	21
23	1SJ19IS027	CHETHANKUMAR H V	8	0	0	0	0	10	0	0	0	0	1	0	8	0	6	3	5	10	5	0	8	12	6	6	7	9	21	3
24	1SJ19IS029	DEEPAK M	10	6	4	10	10	10	10	4	6	10	10	10	8	0	8	2	5	10	0	12	6	12	6	6	6	9	38	34
25	1SJ19IS030	DEEPTHISHREE S	10	6	4	10	10	0	10	4	6	7	7	10	8	4	7	4	6	6	7	10	8	10	6	6	0	9	34	33
26	1SJ19IS031	DEVARAJ PATIL	10	4	0	8	10	10	0	4	6	0	10	0	6	2	6	0	0	0	8	0	8	0	6	6	6	10	26	30
27	1SJ19IS032	D SAI LAVANYA	10	6	0	10	6	2	3	4	6	2	4	0	8	4	6	4	6	10	8	0	8	12	2	2	2	10	34	15
28	1SJ19IS033	DHANYA SURYAMATH	10	1	10	10	7	10	10	0	0	10	10	0	6	4	2	2	2	2	2	2	0	0	2	2	6	10	33	21
29	1SJ19IS034	DHRUTHI R	10	6	2	10	10	4	10	4	6	10	10	5	8	4	8	4	6	5	8	9	8	12	6	6	5	10	37	33
30	1SJ19IS035	G PAVAN NIKIL	0	0	0	0	0	0	0	2	6	0	0	0	2	4	6	2	6	6	6	6	6	6	6	6	2	10	19	12
31	1SJ19IS036	GERIGI YOGA SAI GANESH	5	0	0	6	7	9	1	3	4	0	0	2	7	0	0	0	5	0	4	11	0	0	0	0	0	10	20	12
32	1SJ19IS037	GORAVA DEVENDRA	2	0	0	8	0	0	0	0	1	2	4	0	1	0	8	0	6	0	0	8	0	7	6	6	8	10	19	15
33	1SJ19IS038	GOVARDHAN J A	10	0	0	10	2	10	6	4	6	4	0	4	6	4	0	2	6	0	8	8	8	0	4	0	0	10	23	21
34	1SJ19IS039	GOWTHAM K A	7	5	3	10	10	0	2	3	2	2	10	9	7	2	2	2	4	10	6	12	0	8	3	4	6	10	30	21
35	1SJ19IS040	G BHARGAVI	10	0	9	10	6	10	4	3	6	6	0	6	6	2	6	4	6	0	6	0	0	2	0	0	0	10	34	30
36	1SJ19IS041	GUNASHEKAR G	0	0	0	6	0	0	0	0	0	0	0	0	6	4	2	2	2	6	6	0	6	6	6	2	2	10	19	6
37	1SJ19IS042	H HARI RAJ	3	0	0	2	2	2	0	0	2	0	1	0	5	2	7	0	6	0	8	3	8	8	6	6	8	10	19	13
38	1SJ19IS043	HEMANTH KUMAR N	8	3	0	8	10	10	4	4	6	6	6	0	6	4	0	4	6	6	8	12	0	0	6	0	0	10	24	15
39	1SJ19IS044	HITHAISHI A L	8	3	4	10	10	0	4	4	6	2	5	10	8	0	2	2	3	4	4	2	0	0	5	0	1	10	26	39
40	1SJ19IS045	JAHNAVI D N	4	0	0	2	2	0	0	2	2	0	0	0	8	3	8	0	4	0	3	4	2	12	6	6	8	10	19	12
41	1SJ19IS046	KALAVALA SAIDEEPA	10	6	1	10	7	1	4	4	6	1	10	6	8	4	5	4	5	0	6	8	8	6	6	6	8	10	31	15
42	1SJ19IS047	KALYAN K R	10	0	0	9	0	9	0	0	0	1	2	1	6	2	6	2	6	0	0	0	0	0	6	2	0	10	20	21
43	1SJ19IS048	KAVYA D	10	6	1	10	10	10	10	4	6	10	7	10	8	4	7	0	6	6	8	12	8	10	5	6	6	10	38	37
44	1SJ19IS050	KAVYA D	10	3	10	9	10	9	10	4	6	10	10	10	6	4	8	0	6	10	8	12	0	12	6	6	0	10	38	26
45	1SJ19IS051	KAVYA D R	1	1	0	8	2	0	7	0	2	0	0	0	3	0	2	3	6	6	0	12	6	8	6	1	0	9	19	15
46	1SJ19IS052	KEERTHAN V	10	2	0	8	10	2	10	0	6	0	0	0	0	0	4	2	0	0	1	0	5	0	0	0	0	10	21	11
47	1SJ19IS053	KIRAN S	9	3	4	9	8	0	4	4	6	0	3	4	8	4	6	4	6	6	8	0	5	4	0	0	0	10	26	15
48	1SJ19IS054	LAKSHMIPRIYA Y L	10	3	4	10	7	10	10	2	6	4	10	10	0	2	4	1	5	4	8	10	5	0	6	6	3	9	32	27
49	1SJ19IS055	LAVANYA A	10	5	4	10	8	10	10	4	6	4	10	9	8	4	8	2	6	10	4	12	8	5	3	0	8	10	36	29
50	1SJ19IS056	LAXMIPATHI R	5	3	2	7	3	0	0	4	3	0	4	3	8	0	4	0	0	10	4	2	0	0	0	0	0	10	19	13
51	1SJ19IS057	LITHISHA K J	10	1	10	10	10	10	10	0	0	4	10	4	6	4	8	4	6	6	8	12	0	0	6	6	6	10	37	22
52	1SJ19IS058	MAAKAM GARI SREYA	10	6	4	10	10	10	10	4	6	10	10	10	8	4	8	4	5	10	8	12	8	12	6	6	8	10	40	46
53	1SJ19IS059	MADDURU DINESH	10	6	4	10	10	10	10	4	6	9	5	10	8	4	5	4	6	4	6	12	8	8	6	6	8	10	37	41

54	1SJ19IS060	MADHAVA K V	10	0	0	10	7	10	6	2	4	0	10	0	6	4	4	4	6	10	0	0	8	12	6	6	8	10	32	22
55	1SJ19IS061	MADHAVANAND J BANDI	10	0	0	10	9	0	9	0	5	3	0	3	8	0	7	1	5	0	0	6	0	10	0	0	0	10	24	15
56	1SJ19IS062	MAHENDRA Y J	7	0	2	7	3	0	4	0	3	1	0	0	2	0	4	0	3	2	3	2	5	4	0	0	0	10	19	21
57	1SJ19IS063	MAHINDAR C	10	6	0	9	10	10	0	0	0	0	1	0	6	4	2	2	2	2	2	2	0	0	2	2	6	10	37	27
58	1SJ19IS064	MANASA S	10	6	2	6	10	5	10	0	5	6	10	4	8	4	4	0	2	10	8	10	4	12	5	0	5	10	32	30
59	1SJ19IS065	MANISHA C	10	6	4	10	10	10	10	4	6	9	10	10	8	4	8	4	6	10	8	12	8	12	6	6	8	10	40	39
60	1SJ19IS066	MEGHANA L C	10	6	0	8	6	2	0	4	6	1	1	2	2	4	6	2	6	6	6	6	6	6	6	6	2	10	32	27
61	1SJ19IS067	MEGHANA N S	3	2	0	6	6	0	4	4	6	0	4	2	6	4	0	2	6	0	8	8	8	0	4	0	0	10	23	18
62	1SJ19IS068	MEGHASHREE C V	10	6	0	10	8	8	0	1	0	1	0	0	6	2	6	4	6	0	6	0	0	2	0	0	0	10	29	15
63	1SJ19IS069	MODUPALLI SUNEELA	6	3	0	4	3	0	3	0	2	4	6	4	7	0	0	3	4	3	2	0	3	6	0	0	0	9	19	29
64	1SJ19IS070	MOHAMMED HUZAIFA B	10	0	9	7	0	7	0	0	6	0	0	0	6	4	6	4	6	6	0	0	8	0	6	6	8	10	20	4
65	1SJ19IS071	MOUNIKA D M	6	1	2	10	10	10	10	4	6	8	7	4	4	3	7	2	6	0	3	12	4	10	6	0	2	10	32	23
66	1SJ19IS072	MULLAPUTI PRANEETH	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	2	12	8	12	6	6	5	9	16	10
67	1SJ19IS073	NAVITHA H A	10	3	10	10	10	10	10	0	0	0	10	10	8	4	8	4	6	10	0	0	8	11	6	6	8	10	40	29
68	1SJ19IS074	NAVYA S	8	6	0	10	10	10	2	0	0	1	1	2	6	2	6	2	6	0	0	0	0	0	6	2	0	10	39	35
69	1SJ19IS075	NAVYASHREE A G	10	6	0	10	10	10	10	4	6	0	10	8	6	4	8	0	6	10	8	12	0	12	6	6	0	10	39	31
70	1SJ19IS076	NAYANA K	10	6	4	10	8	10	10	4	6	2	10	7	8	4	8	3	5	10	8	12	5	12	6	6	8	10	38	33
71	1SJ19IS077	NISHA A M	0	0	0	2	3	5	9	2	6	0	5	8	8	0	2	0	0	0	0	10	8	10	0	5	8	10	24	11
72	1SJ19IS078	NITHYA JYOTHI P M	10	6	4	10	10	10	10	4	6	10	10	6	8	4	8	2	5	10	8	12	8	10	6	6	8	10	39	32
73	1SJ19IS079	NITHYA S	2	0	0	4	3	0	10	0	6	0	1	0	8	2	0	0	0	0	3	0	0	0	2	6	8	10	19	21
74	1SJ19IS080	PAVAN KUMAR P S	8	3	4	10	5	10	7	4	5	10	10	10	8	4	6	2	6	9	6	12	8	12	6	6	6	10	37	45
75	1SJ19IS081	POOJA M	9	6	0	8	8	0	4	1	3	0	0	1	6	0	0	0	0	0	6	2	0	4	5	5	1	9	20	17
76	1SJ19IS082	PRAFUL PRAKASH KULKARNI	2	0	2	5	3	0	0	0	3	0	2	0	5	0	0	0	0	0	1	0	8	12	0	0	0	10	16	7
77	1SJ19IS083	PRAJWAL P	10	5	4	10	10	10	10	4	6	8	7	5	8	4	5	4	6	10	8	12	8	10	6	6	7	10	38	29
78	1SJ19IS084	PRAKRUTHI C	10	6	4	8	10	10	10	4	6	10	10	10	8	4	8	4	6	10	8	12	8	12	6	6	7	10	40	33
79	1SJ19IS085	PRAVEEN S	4	1	4	4	6	0	10	4	6	1	2	2	4	1	5	2	3	8	6	1	0	4	6	6	2	10	23	23
80	1SJ19IS086	PREKSHITHA D	6	6	0	8	10	6	6	4	6	2	6	6	6	4	8	4	6	6	8	12	0	0	6	6	6	10	29	21
81	1SJ19IS087	PRIYA S	10	5	4	8	10	10	10	2	4	5	7	6	8	4	4	2	3	6	5	6	3	7	6	6	4	10	33	23
82	1SJ19IS088	R SAI ABHIRAM	5	0	1	4	10	2	4	3	5	4	6	5	6	2	3	0	4	4	4	8	7	7	4	1	4	10	26	21
83	1SJ19IS089	RACHAN S H	9	2	3	7	0	0	0	0	4	0	3	0	8	0	0	0	0	0	4	2	0	0	6	6	8	10	20	18
84	1SJ19IS090	RADHIKA P	10	2	0	10	10	6	0	0	6	0	0	6	6	4	4	4	6	10	0	0	8	12	6	6	8	10	29	21
85	1SJ19IS091	RAKSHA M	10	6	3	10	9	10	7	4	6	6	7	10	8	4	6	4	5	10	6	8	8	12	6	6	7	9	36	39
86	1SJ19IS092	S JAYANTH	7	0	0	5	3	9	0	1	2	0	6	3	8	0	0	0	6	0	4	1	0	0	0	0	0	10	19	9
87	1SJ19IS093	S N RAKESH	10	2	0	8	8	9	2	4	6	2	1	1	6	4	6	4	6	6	0	0	8	0	6	6	8	10	26	29
88	1SJ19IS094	S P VIDYA SAGAR	10	0	10	7	4	7	8	4	4	1	4	2	6	4	8	2	6	6	8	12	8	11	6	6	6	10	26	11
89	1SJ19IS095	SAHANA D R	10	4	10	10	10	10	4	4	6	6	10	4	2	2	6	4	6	6	0	0	8	8	6	6	6	10	39	23
90	1SJ19IS096	SANDHYA D M	10	2	0	8	10	2	0	4	6	10	8	6	8	4	8	4	6	10	0	0	8	11	6	6	8	10	28	21
91	1SJ19IS097	SANJANA DHARMAVAR	10	0	10	10	10	10	4	0	0	6	0	4	6	4	2	0	0	0	0	0	8	0	6	6	6	10	33	37
92	1SJ19IS098	SANJAY M	10	6	4	0	0	10	0	4	4	0	2	2	7	4	0	4	5	0	0	0	8	0	6	0	0	9	21	9
93	1SJ19IS099	SAQLAIN ULLA KHAN A	4	0	4	8	8.5	0	6	1	6	0	10	3	5	0	7	0	6	3	4	2	0	0	0	0	0	10	23	21
94	1SJ19IS100	SHIVA PRASAD C	5	3	2	8	7	0	0	0	0	0	3	5	8	2	4	0	5	0	3	7	5	6	0	2	0	10	22	24
95	1SJ19IS101	SHREYAS M	7	3	0	5	3	5	0	0	6	0	5	0	8	0	3	0	0	0	7	0	0	4	0	0	0	9	18	18
96	1SJ19IS102	SHUBHAVARNA N	10	6	4	10	10	10	10	4	6	8	8	6	8	4	8	4	6	10	8	8	8	12	5	5	8	10	38	28
97	1SJ19IS103	SIDDESH GUNDAGI	7	0	1	8	10	4	10	1	0	6	6	4	8	0	4	0	0	4	6	4	0	7	3	0	0	7	22	13
98	1SJ19IS104	SINDHURA N	7	5	4	8	10	10	10	4	6	10	8	10	8	4	4	3	6	6	8	12	8	9	6	6	6	10	37	29
99	1SJ19IS105	SNEHA G S	3	4	0	7	2	0	0	2	4	0	1	0	8	3	4	0	3	4	8	2	5	0	2	0	7	10	19	18
100	1SJ19IS106	SNEHITH PRASAD C H	10	2	2	8	4	8	4	4	6	4	5	6	8	4	6	0	0	3	6	9	0	7	6	0	8	10	29	32
101	1SJ19IS107	SPOORTHI S SURESH	10	3	2	0	10	10	10	4	3	6	10	10	8	4	8	4	6	8	8	12	8	12	6	6	8	10	36	35
102	1SJ19IS108	SRINIDHI B V	10	1	4	10	10	10	10	4	5	10	10	10	8	4	8	4	6	7	8	12	6	8	6	6	8	10	38	36
103	1SJ19IS109	SUHAIL KHAN I	2	0	10	10	10	10	0	4	4	4	6	2	6	4	0	4	6	0	8	6	0	0	2	1	0	10	27	21
104	1SJ19IS110	SUHAS A	2	6	9	7	0	7	2	0	0	4	0	4	6	2	6	4	6	0	8	12	0	0	6	0	0	10	26	23
105	1SJ19IS111	SUJANA RAGHAVENDRA S	5	1	4	9	6	0	5	4	6	2	9	7	8	0	4	0	2	6	7	5	6	6	3	4	2	10	27	21
106	1SJ19IS112	SUMERA SULTANA S	5	2.5	0	2	0	0	0	2	0	0	2	2	8	2	5	0	0	0	0	0	0	0	0	0	0	10	16	15
107	1SJ19IS113	SWAROOP N SWAMY	10	0	0	7	3	0	10	4	6	3	9	4	8	0	2	2	6	0	5	10	0	2	2	6	8	10	27	14
108	1SJ19IS114	SWATHI N	10	2	0	10	8	0	9	4	6	10	8	1	6	0	4	0	6	4	0	10	8	7	0	6	0	10	29	26
109	1SJ19IS115	SYED TAMEEN	10	0	7	6	1	6	0	0	0	8	0	6	6	4	6	2	6	6	0	0	8	11	6	6	0	10	19	11
110	1SJ19IS116	TEJAS S KUMAR	A	A	A	A	A	A	7	4	6	5	6	7	3	2	7	2	5	8	8	7	8	10	6	6	8	9	24	26

111	1SJ19IS117	THARUN P C	10	3	2	8	10	7	10	4	6	7	6	10	8	3	8	4	6	10	8	9	8	6	3	4	8	10	36	46
112	1SJ19IS118	UDAYKUMAR J B	10	6	0	10	10	10	10	4	6	6	10	9	6	4	8	2	6	6	8	12	8	11	6	6	6	10	34	27
113	1SJ19IS119	VANDANA K	10	6	2	10	10	7	10	4	6	8	5	10	8	4	8	4	6	10	8	12	8	12	6	6	8	10	38	35
114	1SJ19IS120	VASUKI M	9	0	0	7	3	0	8	4	5	2	0	2	8	3	4	4	4	2	5	1	5	5	1	0	0	10	22	21
115	1SJ19IS121	VAYALPAD MOHAMMAD THOUHID	5	1	0	9	2	0	0	1	6	0	8	8	8	0	0	0	0	7	2	0	0	0	0	0	0	9	19	15
116	1SJ19IS122	VEERAVALLI MAHENDRA	3	0	0	1	0	0	0	2	0	0	0	0	0	1	0	0	2	0	6	12	0	0	6	6	8	10	16	18
117	1SJ19IS123	VIKHYATH P	10	2	9	10	4	10	2	0	0	4	2	2	6	2	6	4	6	8	8	12	8	0	6	6	2	10	26	21
118	1SJ19IS124	YARRAGUNTLA CHANDANA	10	0	1	8	6	10	4	4	6	5	6	4	8	4	7	0	5	10	8	8	8	7	0	6	0	9	29	21
119	1SJ19IS125	YASHASWINI H S	10	4	0	9	6	2	0	0	0	2	2	3	2	2	6	4	6	6	0	0	8	8	6	6	6	10	30	23
120	1SJ19IS126	YASHASWINI S	10	6	4	9	8	9	2	4	3	0	0	0	8	2	5	3	4	3	8	7	5	5	6	0	7	10	27	4
Course Outcomes			**CO1**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO3**	**CO2**	**CO2**	**CO3**	**CO1**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO3**	**CO3**	**CO4**	**CO4**	**CO5**	**CO5**	**CO5**	**CO1-CO5**		**CO1-CO5**
Total No. of Students			**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**		**120**
SEE			**36**	**31**	**34**	**43**	**34**	**27**	**33**	**33**	**41**	**20**	**27**	**21**	**39**	**28**	**27**	**19**	**39**	**20**	**29**	**39**	**38**	**31**	**38**	**36**	**27**	**120**		**30**
No. of students absent			**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**
% of Students scored 70% & above in CIE and 50% & above in SEE			**30.25**	**26.05**	**28.57**	**36.13**	**28.57**	**22.69**	**27.50**	**27.50**	**34.17**	**16.67**	**22.50**	**17.50**	**32.50**	**23.33**	**22.50**	**15.83**	**32.50**	**16.67**	**24.17**	**32.50**	**31.67**	**25.83**	**31.67**	**30.00**	**22.50**	**100.00**		**25.00**
																												Level		**Level**
																												3		**0**

Averagre CO1 attainment	**31.38**
Average CO2 attainment	**24.79**
Average CO3 attainment	**27.08**
Average CO4 attainment	**28.75**
Average CO5 attainment	**28.06**
Average CO attainment	**28.01**
Level	**0**

Level 1	**50**
Level 2	**55**
Level 3	**60**

CO attainment Direct IA (Test + Assignment) = (75% of Test + 25% of Assignment) = (0.75 X 0)+(3 x 0.25) =	**0.75**	
CO Attainment Direct (SEE)	**0**	
CO Attainment Direct (IA + SEE) = (0.5 x IA + 0.5 x SEE) = (0.5 x 0.75 + 0.5 x 0) =	**0.375**	
CO Attainment Indirect	**3**	
Over all CO attainment = (0.8 x Direct + 0.2 x Indirect) = (0.8 x 0.375 + 0.2 x 3)	**0.9**	**1**

From DHI
Course End Survey Feedback
Avg Value 2.5 = 3

CO-PO ATTAINMENT

CO/PO'S	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	P010	PO11	PO12	PSO1	PSO2
CO1	1									1				
CO2	3	2	3							1			2	
CO3	3	3			2					1			2	
C04	3	2								1			2	
C05	3	2								1			2	
AVG.	2.6	2.25	3		2					1			2	

Overall CO attainment = 1

CO-PSO ATTAINMENT

COS/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Avg.	2.6	2.25	3		2					1			2	
Attainment Achieved	0.87	0.75	1.00		0.67					0.33			0.67	

NOTE:

WEIHTAGE CONSIDERED FOR ATTAINMENT CALCULATION: 50% FOR BOTH IA AND EE

ATTAIMENT ACHIEVED :	(Attainment value*PO Avg. Value) / Maximum Value

DEPARTMENT OF CIVIL ENGINEERING

LESSON PLAN - LECTURE

Subject : Elements of Civil Engineering & Mechanics — **Code: 18CIV14**
Semester : I — **Sec** : I
Faculty : Sathish Y A

Course Objectives:

The objective of this course are:

- To make students to learn scope of various fields of Civil Engineering, basics of civil engineering concepts and importance of infrastructure development.
- To develop a student's ability to analyze the problems involving forces and moments with their applications, centroid and moment of inertia and kinetics of bodies.

Prerequisite(s): I & II PU Physics and Mathematics

Course Outcomes:

After a successful completion of the course, the student will be able to :

1. Outline the scope of different fields of civil engineering and role of civil engineer in the infrastructure development.
2. Identify the resultant of coplanar force system and frictional force.
3. Analyze the statically determinate beams and trusses.
4. Identify the centroid and moment of inertia of built-up sections.
5. Define the characteristics of motion of bodies and analyze the bodies in motion.

It is basic subject for: Strength of Materials, Fluid Mechanics, Structural Analysis

Subject Applications: To know the basic concepts of Civil Engineering

Module	Topic	Planned		Actual		Remarks
		No. of Hour	Date	No. of Hour	Date	
Module 1 - Introduction To Civil Engineering & Engineering Mechanics	**Introduction to Civil Engineering:** Scope of different fields of Civil Engineering, Role of Civil Engineers in the Infrastructural development & Effect of Infrastructure facility	01	26-08-19	01	26/08/19	As per plan
	Introduction to Engineering Mechanics- Basic concepts of idealization, force, System of forces, Principles of mechanics(3), Newton's laws of Motion, Resolution and Composition of force,	01	27-09-19	01	27/08/19	As per plan
	Law of Parallelogram of forces, Polygonal law, Resultant of coplanar concurrent force system, Moment of force, Couple	01	03-09-19	01	03/09/19	as per plan
	Varignon's theorem, Resultant of coplanar non-concurrent force system	01	09-09-19	01	09/09/19	as per plan

Module 2 - Equilibrium of Forces & Friction	**Equilibrium of forces:** Free body diagram, Lami's theorem, Equations of Equilibrium,	01	16-09-19	1/2	17/09/19	∵ Freshers Day function conducted on 16/09/19
	Equilibrium of concurrent force system, Equilibrium of non-concurrent force system	01	17-09-19	1/2	17/09/19 using ppt	
	I Internals: 23-09-2019 to 30-09-2019					
	Friction: Types of friction, Laws of dry friction, Limiting friction, Angle of friction, Angle of repose,	01	01-10-19	1	30/09/19	∵ Internals Completed on 27/09/19
	Wedge & Ladder friction Rope and pulley systems	01	14-10-19	1	14/10/19	
Module 3 - Support Reactions & Analysis of Simple Trusses	**Support Reactions:** Types of loads and Supports, Statically determinate and indeterminate beams	01	15-10-19	1	21/10/19	
	Support Reactions in beams	01	21-10-19	1	22/10/19	
	Analysis of simple trusses: Types of trusses, Analysis of statically determinate trusses using method of joints	01	22-10-19	1	11/11/19	
	Analysis of statically determinate trusses using method of sections	01	28-10-19	1	12/11/19	
	II Internals: 04-11-2019 to 09-11-2019					
Module 4 – Centroid & Moment of Inertia	**Centroid:** Centroid of simple figures from first principle,	01	11-11-19	1	18/11/19	
	Centroid of composite/built–up sections	01	12-11-19	1	19/11/19	
	Moment of inertia: Introduction, Second moment of area of plane sections from first principles, Parallel axis theorem, Perpendicular axis theorem	01	18-11-19	1/2	26/11/19	used Power point presentation.
	Radius of gyration, Moment of inertia of composite area and built-up sections, Concept of Product of Inertia	01	19-11-19	1/2	26/11/19	
Module 5 - Kinematics & Kinetics	**Kinematics:** Definitions of terms used in Kinematics, Newton's law of motion,	01	25-11-19	1	02/12/19	used ppt.
	Rectilinear motion, Curvilinear motion,	01	26-11-19		02/12/19	
	Projectile motion, Motion under gravity	01	02-12-19	1	03/12/19	
	Kinetics: D'Alembert's principle and its applications in plane motion Applications in connected bodies including pulleys	01	03-12-19	1	03/12/19	used power point presentation
	III Internals : 09-12-2019 to 14-12-2019					

Assignments and Mini Project	
Assignment – I Submitted on:	23/12/2019
Assignment – II Submitted on:	
Assignment – III Submitted on:	

Literature to be Referred for the Course:

Book Type	Code	Title & Author	Publisher
Text Books	T1	"Engineering Mechanics: Principles of Statics and Dynamics", R C Hibbler	Pearson Press
	T2	"A Text book of Engineering Mechanics", Bansal R K	Laxmi Publications
Reference Books	R1	"Introduction to Statics and Dynamics" Andy Ruina and Rudra Pratap	Oxford University Press
	R2	"Engineering Mechanics" Reddy Vijayakumar K and D Suresh Kumar	Singer's
	R3	"Mechanics for Engineers-Dynamics and Statics", Beer F P and Johnson ER	Mc Graw Hill
	R4	"Engineering Mechanics", Irving H Shames	Prentice Hall

Comments by Faculty: Syllabus executed as per plan

Comments by HOD: SYLLABUS COVERED IS 100 -/. 23/12/19

Note: Plan and execution is for 5 Modules (Only Lecture Classes).

Prepared by	Mr. SATHISH Y A	Reviewed by	Mr. MANJUNATH SIDDAPPA	Approved by	Dr. S BHARGAVI
Date & sign	26/08/19	Date & sign	2d 8/19	Date & sign	26/08/19

|| Jai Sri Gurudev ||

S J C Institute of Technology, Chickballapur

Department of Civil Engineering Department

Assignment

Subject : Elements of Civil Engineering and Mechanics — Code : 18CIV14

Sem & Sec : I Sem, 'D' and 'I' Sec — Marks : 10

Note:

a) ***Answer the following questions.***

b) ***USN = Last 3 digits in University Seat Number (Eg: USN – 1SJ19CV098, then value =098)***

c) ***Marks distribution: Question No. 1 to 6 = 1 marks & Question No. 7 & 8 = 2 marks***

1. Four forces acting on the gusset plate of a joint in a bridge truss are shown in Fig.Q1. Determine the value of 'P' and 'Θ' to maintain the equilibrium of the joint.
2. Determine the resultant of the force system acting on a body as shown in the Fig.Q2 with respect to point 'O'.
3. Two spheres each of radius 100 mm and weight USN (kN) is in a rectangular box as shown in Fig.Q3. Calculate the reactions at all the points of contact.
4. In the Fig.Q4. The portion BC of the string is horizontal and pulley is frictionless. Determine tension in different parts of the string. Also find W_1 and W_2.
5. Solve for the distance X such that the reaction R_A and R_B is equal for the beam shown in Fig.Q5.
6. Find the support reactions and member forces for pin jointed plane truss shown in Fig.Q6. By method of joints.
7. Determine the position of centroid for the shown Fig.Q7.
8. Determine the moment of inertia for the shaded area shown in Fig.Q8. with respect to X and Y axis.

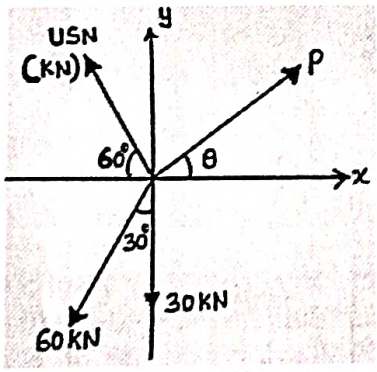


Fig.Q1.

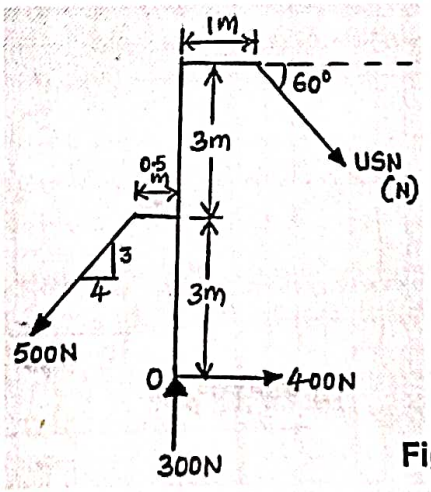


Fig.Q2.

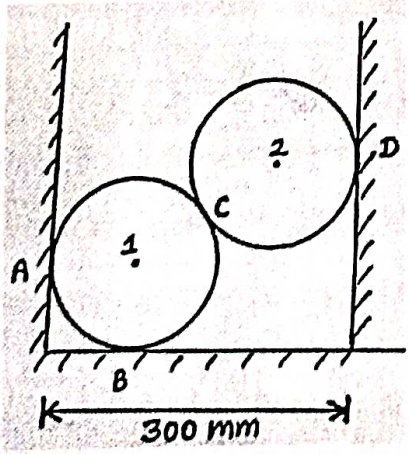


Fig.Q3.

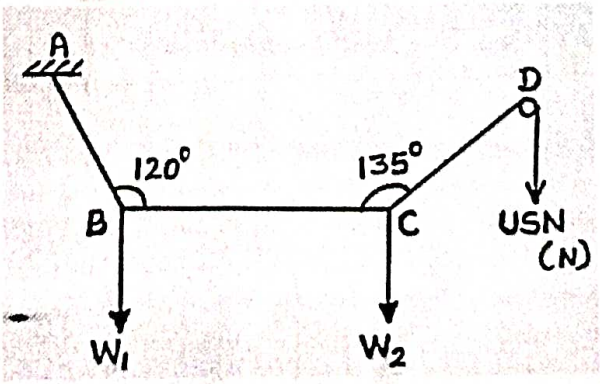


Fig.Q4.

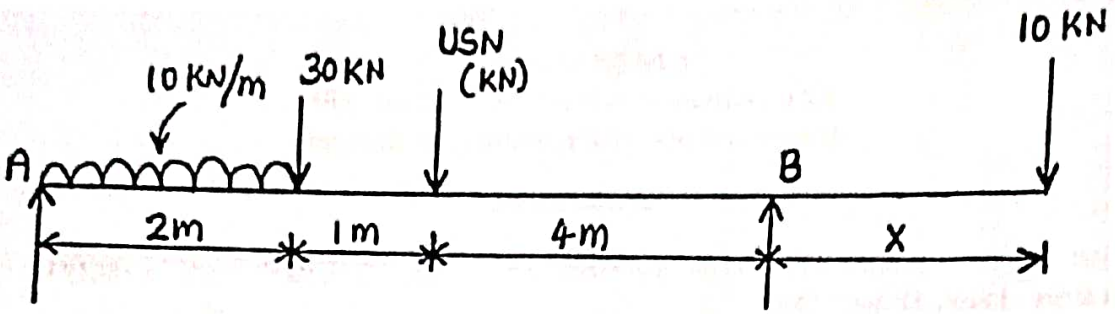


Fig.Q5.

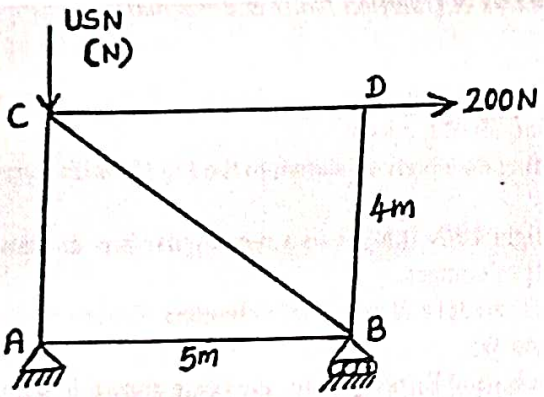


Fig.Q6.

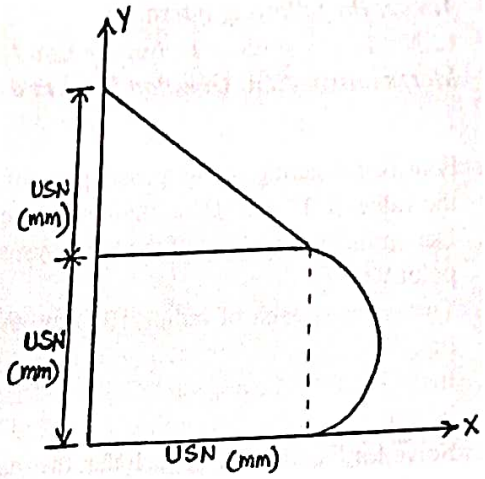


Fig.Q7.

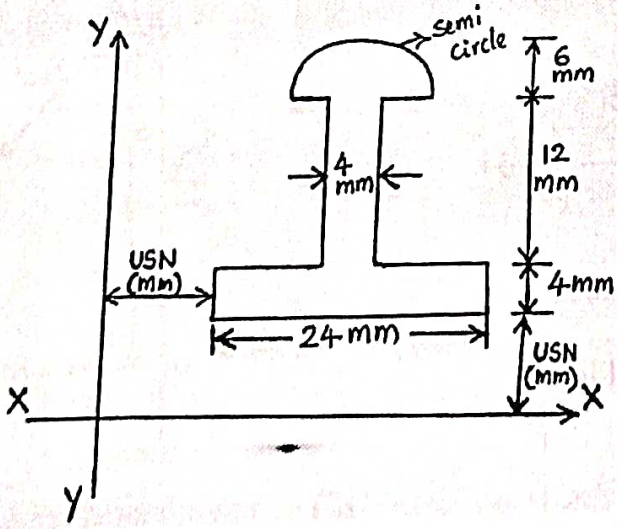


Fig.Q8.

USN	Problem 1		Problem 3				Problem 4			Problem 5		Problem 7	
	θ	P	RC	RD	RA	RB	W2 = TBC	W1	TAB	VA = VB	X	x	y
1	69.39	86.64	1.15	0.58	0.58	2	0.71	1.22	1.41	30.50	6.05	0.60	0.72
2	68.87	86.01	2.31	1.15	1.15	4	1.41	2.45	2.83	31.00	6.10	1.21	1.44
3	68.35	85.39	3.46	1.73	1.73	6	2.12	3.67	4.24	31.50	6.15	1.81	2.16
4	67.82	84.77	4.62	2.31	2.31	8	2.83	4.90	5.66	32.00	6.20	2.41	2.88
5	67.28	84.16	5.77	2.89	2.89	10	3.54	6.12	7.07	32.50	6.25	3.02	3.60
6	66.74	83.56	6.93	3.46	3.46	12	4.24	7.35	8.49	33.00	6.30	3.62	4.32
7	66.18	82.96	8.08	4.04	4.04	14	4.95	8.57	9.90	33.50	6.35	4.23	5.04
8	65.62	82.38	9.24	4.62	4.62	16	5.66	9.80	11.31	34.00	6.40	4.83	5.76
9	65.05	81.80	10.39	5.20	5.20	18	6.36	11.02	12.73	34.50	6.45	5.43	6.48
10	64.48	81.23	11.55	5.77	5.77	20	7.07	12.25	14.14	35.00	6.50	6.04	7.20
11	63.89	80.67	12.70	6.35	6.35	22	7.78	13.47	15.56	35.50	6.55	6.64	7.92
12	63.30	80.11	13.86	6.93	6.93	24	8.49	14.70	16.97	36.00	6.60	7.24	8.64
13	62.70	79.57	15.01	7.51	7.51	26	9.19	15.92	18.38	36.50	6.65	7.85	9.36
14	62.09	79.03	16.17	8.08	8.08	28	9.90	17.15	19.80	37.00	6.70	8.45	10.08
15	61.47	78.51	17.32	8.66	8.66	30	10.61	18.37	21.21	37.50	6.75	9.06	10.80
16	60.84	77.99	18.48	9.24	9.24	32	11.31	19.60	22.63	38.00	6.80	9.66	11.52
17	60.21	77.48	19.63	9.81	9.81	34	12.02	20.82	24.04	38.50	6.85	10.26	12.24
18	59.56	76.98	20.78	10.39	10.39	36	12.73	22.05	25.46	39.00	6.90	10.87	12.96
19	58.91	76.49	21.94	10.97	10.97	38	13.44	23.27	26.87	39.50	6.95	11.47	13.68
20	58.25	76.02	23.09	11.55	11.55	40	14.14	24.49	28.28	40.00	7.00	12.07	14.40
21	57.58	75.55	24.25	12.12	12.12	42	14.85	25.72	29.70	40.50	7.05	12.68	15.12
22	56.91	75.09	25.40	12.70	12.70	44	15.56	26.94	31.11	41.00	7.10	13.28	15.84
23	56.22	74.64	26.56	13.28	13.28	46	16.26	28.17	32.53	41.50	7.15	13.89	16.56
24	55.53	74.21	27.71	13.86	13.86	48	16.97	29.39	33.94	42.00	7.20	14.49	17.28
25	54.83	73.78	28.87	14.43	14.43	50	17.68	30.62	35.36	42.50	7.25	15.09	18.00
26	54.12	73.37	30.02	15.01	15.01	52	18.38	31.84	36.77	43.00	7.30	15.70	18.72
27	53.40	72.96	31.18	15.59	15.59	54	19.09	33.07	38.18	43.50	7.35	16.30	19.44
28	52.68	72.57	32.33	16.17	16.17	56	19.80	34.29	39.60	44.00	7.40	16.90	20.16
29	51.95	72.19	33.49	16.74	16.74	58	20.51	35.52	41.01	44.50	7.45	17.51	20.88
30	51.21	71.83	34.64	17.32	17.32	60	21.21	36.74	42.43	45.00	7.50	18.11	21.60
31	50.46	71.47	35.80	17.90	17.90	62	21.92	37.97	43.84	45.50	7.55	18.72	22.32
32	49.70	71.13	36.95	18.48	18.48	64	22.63	39.19	45.25	46.00	7.60	19.32	23.04
33	48.94	70.80	38.11	19.05	19.05	66	23.33	40.42	46.67	46.50	7.65	19.92	23.76
34	48.17	70.48	39.26	19.63	19.63	68	24.04	41.64	48.08	47.00	7.70	20.53	24.48
35	47.40	70.17	40.41	20.21	20.21	70	24.75	42.87	49.50	47.50	7.75	21.13	25.21
36	46.61	69.88	41.57	20.78	20.78	72	25.46	44.09	50.91	48.00	7.80	21.73	25.93
37	45.83	69.60	42.72	21.36	21.36	74	26.16	45.32	52.33	48.50	7.85	22.34	26.65
38	45.03	69.33	43.88	21.94	21.94	76	26.87	46.54	53.74	49.00	7.90	22.94	27.37
39	44.23	69.08	45.03	22.52	22.52	78	27.58	47.77	55.15	49.50	7.95	23.55	28.09
40	43.42	68.84	46.19	23.09	23.09	80	28.28	48.99	56.57	50.00	8.00	24.15	28.81

Internal Test Question paper format- CBCS Scheme

Name of the staff/s: Mr. SATHISH Y A , Mr. SUHAS K B &Mr. SACHIN H R
Date: 6.12.2019 Signature: 6/12/19

Reviewer's Signature: 06/12/19

S.J.C. Institute of Technology

Department: CIVIL ENGINEERING

Test: III

Semester: I
Year: 2019-20
Duration: 120 minutes
Subject Name: ELEMENTS OF CIVIL ENGINEERING & MECHANICS
INSTRUCTIONS: i) Answer *FIVE* full questions

Section: A, B, E, F, G, L
Subject Code: 18CIV14
Max Marks: 100

Q.No.		Marks	COs	Levels
1.a	Explain the role of civil engineer in the infrastructural development of a country	08	CO1	L2
b	Explain the following (1) Principle of superposition of forces (2)Transmissibility of forces	04	CO2	L2
c	Determine the magnitude and direction of resultant of concurrent coplanar system of forces shown in **fig Q 1. c**	08	CO2	L2
	OR			
2.a	Explain the following fields of Civil Engineering in brief (1) Structural Engineering (2) Hydrology & Irrigation (3) Transportation Engineering (4) Geotechnical Engineering	08	CO1	L2
b	Explain the following (1) Composition of forces (2) Resolution of forces	04	CO2	L2
c	Determine the magnitude, direction and position of resultant with respect to the point A for the force system as shown in **Fig Q 2.c**	08	CO2	L2
3a	Explain the following (1) Free body diagram (2)Equilibrium	04	CO2	L2
b	State and prove Lamis theorem. Also write the significance of law	06	CO2	L2
c:	Two smooth spheres each of radius 100mm and weight 200N rests in a channel as shown in **Fig Q 3.c**.Determine the normal reactions at points A,B and C on the channel	10	CO2	L3
	OR			
4a	Explain (1)Angle of repose (2)cone of friction	04	CO2	L2
b	Distinguish between static friction and kinetic friction also list any 2 laws of static friction	06	CO2	L2
c	A ladder weighing 200N is to be kept in position as shown in **Fig Q 4.b** resting on a smooth floor and leaning against a small wall. Determine the horizontal force required to prevent it from slipping and leaning against a small wall. Determine the horizontal force required to prevent from slipping when a man weighing 700N is at a height of 2m above the floor level	10	CO2	L3
5a	With neat sketch explain different types of supports and mark their reaction line. List the different types of beams	08	CO3	L2
b	Find the support reactions for the beam loaded as shown in **fig Q 5.b**	12	CO3	L3
	OR			

6a	List the different steps involved in the analysis of truss by method of section	08	CO3	L2
b	Find the support reaction and members forces for pin jointed plane truss as shown in fig Q 6 b by method of joints	12	CO3	L3
7a	Derive an expression for the centroid of a right angle triangle	08	CO4	L2
b	Locate the centroid of shaded area as shown in fig Q 7b	12	CO4	L3
	OR			
8a	State & prove parallel axis theorem	08	CO4	L2
b	Determine moment of inertia (second moment of area) about the horizontal centroidal axis and also find the radius of gyration	12	CO4	L3
9a	Define the following (1) Displacement (2) Rectilinear motion (3) Curvilinear motion (4) Velocity	06	CO5	L2
b	What is super elevation? Explain the objectives of providing super elevation	06	CO5	L2
c	A stone is dropped into a well and the splash of sound is heard after 9 seconds. Determine the height of drop from the water surface. Assume velocity of sound to be 330m/s	08	CO5	L3
	OR			
10a	Define the following (1)speed (2) Acceleration (3) uniform acceleration (4)Acceleration due to gravity	06	CO5	L2
b	State D Alembert principle and mention its applications in plane motion	06	CO5	L2
c	A particle is projected with a velocity of 20m/s in air at angle θ with the horizontal. The x and y coordinates of point lying on the trajectory of the particle with respect to point of projection are 20m and 8m respectively. Find the angle of projection of the particle	08	CO5	L3

CO1=8M	CO2=32M	CO3=20M	CO4=20M	CO5=20M	L1=0M	L2=60	L3=40	L4=0	L5=0	L6=0

CO1	Outline the scope of different fields of civil engineering & role of civil engineering in infrastructure development
CO2	Identify the resultant coplanar forces system & frictional forces
CO3	Analyze the statically determinate beams & trusses
CO4	Identify the centroid & moment of inertia of builtup sections
CO5	Define the characteristics of motion of bodies & analyze the bodies in motion

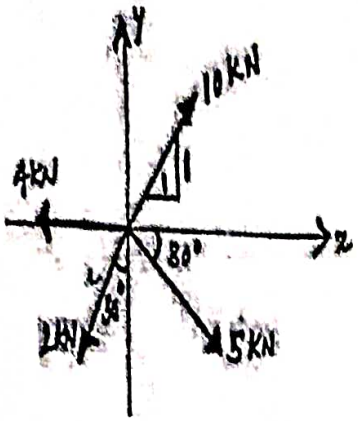


Fig Q 1. C

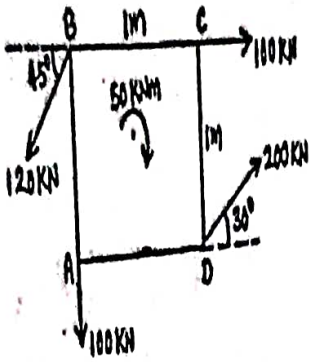


Fig Q 2.C

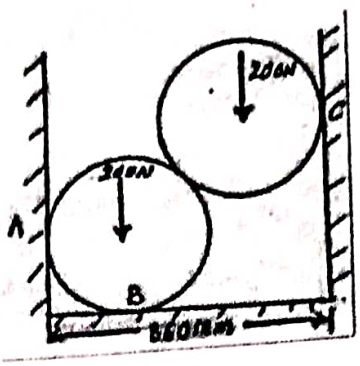


Fig Q 3.C

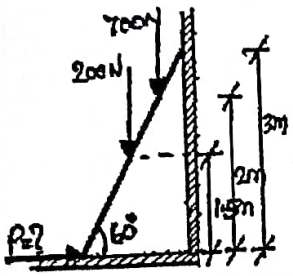


Fig Q 4.b

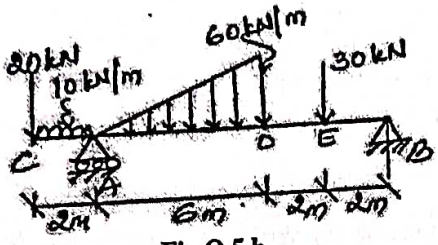


Fig Q 5.b

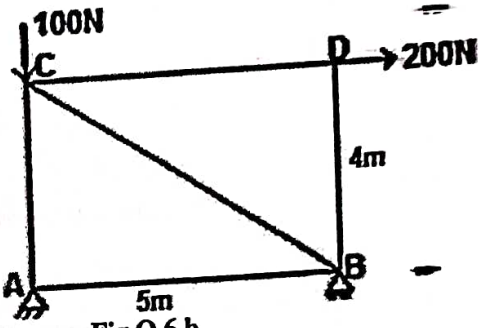


Fig Q 6.b

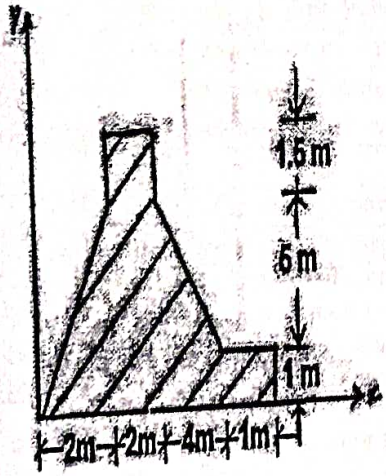


Fig Q 7b

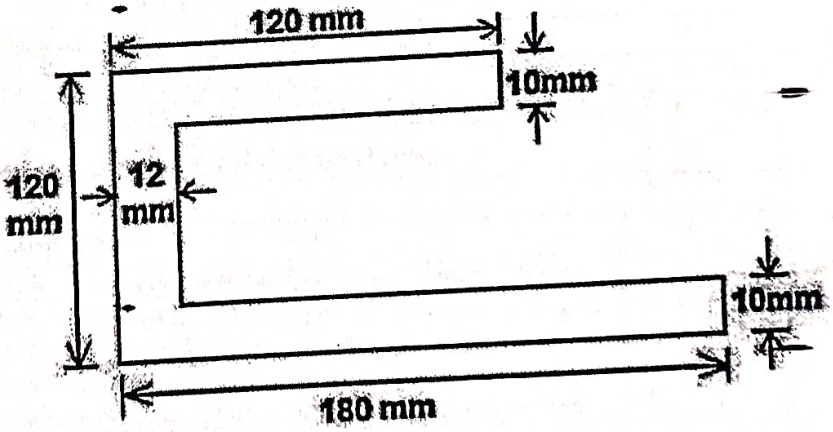


Fig Q 8 b

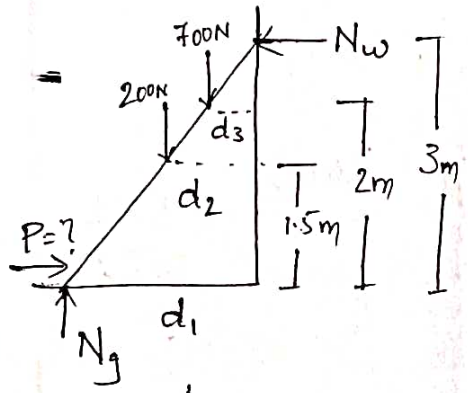
DEPARTMENT: FIRST YEAR ENGINEERING

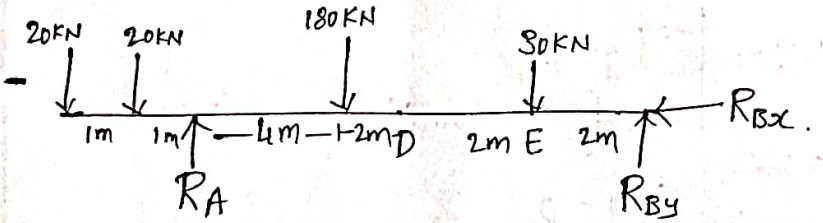
Scheme & Solutions-Test 3

Semester: 1 **Subject Title: Elements of Civil Engg & mechanics** **Subject Code:18CIV14**

Question Number	Solution	Marks Allocated
1.(a)	Any 8 points .... 1M X 8	8 M
(b)	Statement - POSOF .... 2M - POTOF 2M	4M
(c)	$\Sigma F_x = 6.40$ KN ... 2M | $\theta = 45°$ ... 1M $\Sigma F_y = 2.83$ KN .... 2M | $R = 7$ KN .... 2M $\alpha = 23.8°$ 1M	8 M
	(OR)	
2 (a)	4 fields of civil Engg. ... 2M X 4 - 2 points for each	8M
(b).	composition: Definition ... 1M Sketch ... 1M Resolution: Definition .... 1M Sketch ... 1M	4M
(c)	$\Sigma F_x = 188.35$ KN ... 1M $\Sigma F_y = -84.85$ KN ... 1M $\Sigma M_A = -34.85$ KN-m 1M, R= 206.57 KN ... 1M d = 0.16 m .... 1M $\alpha = -24.85°$ .. 1M x = 0.410 m ... 1M y = 0.185 m 1M	8M

Question Number	Solution	Marks Allocated
3(a)	Free body Diagram - Defin ... 1M Ex/Sketch ... 1M Equilibrium - Defin ... 1M Equations ... 1M	4M
(b)	Lami's theorem: Statement ..... 2M Sketch .... 1M Applying Sine rule ... 1M Final eqn ... 1M Significance ... 1M.	6M
(c)	$\theta_1 = 36.86°$ $(\theta_2 = 53.14)$ ... 2M FBD of S-1 & S-2 .... 2M $R_A = 266.76N$ .... 1.5M $R_B = 400\ N$ .... 1.5M $R_C = 266.76N$ .... 1.5M $R_D = 333.41N$ 1.5M	10M

Question Number	Solution	Marks Allocated
4.(a)	Angle of repose - Defn ... 1M Sketch ... 1M Cone of friction - Defn ... 1M Sketch ... 1M	4M
(b)	 ..... 2M $d_1 = 1.732m$ ... 1M $d_2 = 0.867m$ ... 1M $d_3 = 0.57m$ ... 1M $\Sigma F_y = 0$ $N_g = 900\,N$ ... 2M $\Sigma M = 0$ $P = 328.8\,N$ 3M	10M
(b)	Any 4 differences ... 1M X4 Any 2 Laws of fric^n ... 1M X2	6M

Question Number	Solution	Marks Allocated
5 (a)	Types of Support (Four) ... 1.5X 4 = 6M 1. Simple (1 point + Sketch) 2. Roller (— " —) 3. Hinged / pinned (- " -) 4. Fixed (— " —) List any 4 types beams ... 0.5X4 = 2M	8M
(b)	 UDL → PL 10 X 2 = 20KN ... 1M UVL - PL $\frac{1}{2}$ X 6 X 60 = 180 KN .. 1M FBD ..... 2M $\Sigma f_y = 0$ $R_A + R_{BY} = 250$ ..... 3M (2+1) $\Sigma M = 0$ $R_A = 160$ KN ..... 3M (2+1) R_{BY} or $R_B = 90$ KN 2M	12M

Question Number	Solution	Marks Allocated
6(a)	Method of Section: Sketch ... 2M procedure .... 2M X 3 = 6M (Min 3 points).	8M
(b)	$F_{CD} = 200N$ ..... 2M $F_{DA} = 60N$ ..... 2M $F_{CB} = 0$ ..... 2M $F_{BA} = 200N$ ..... 2M $F_{DB} = -256.12N$ ..... 2M. $R_{Ax} = 200N$ ..0.5M / $R_{Ay} = -60N$ ..0.5M $R_B = 160N$ 1M	12M

Question Number	Solution	Marks Allocated
7 (a)	- Derivation of centroid Sketch ... 2M - Area of Element .. 1M Moment of Area Element .. 1M Total moment of Area .. 1M Equating eqns .... 1M (Apply principle of moments) - $\bar{x} = \frac{b}{3}$ ... 1M $\bar{y} = \frac{d}{3}$ or $\frac{h}{3}$ 1M	8M
(b)	Sketch ... 2M $\Sigma A = 36 m^2$ ..... 2M $\Sigma Ax = 138.78 m^3$ ..... 2M $\Sigma Ay = 97.35 m^3$ ... 2M - $\bar{x} = 3.85$ m, (formula - 1M) ... 2M $\bar{y} = 2.70$ m (— 11 —) ... 2M	12M

Question Number	Solution	Marks Allocated
8(a)	Sketch . . . . 2M MoI about centroidal axis . . . . . 1M MoI about Reference axis . . . 1M. Final eqn $I_{1-1} = \bar{I}_x + A\bar{y}^2$ . . . . 2M. Statement . . . . . 2M.	8M
8(b)	→ $\Sigma A = 4200\ mm^2$ . . . 2M $\Sigma Ax = 2.412 \times 10^5\ mm^3$ → $\Sigma Ay = 2.19 \times 10^5\ mm^3$ . . . . 2M $\Sigma Ax^2 = 18.96 \times 10^6\ mm^4$ → $\Sigma Ay^2 = 20.23 \times 10^6\ mm^4$ . . . 2M → $\Sigma \bar{I}_x = 1.025 \times 10^6\ mm^4$ . . . . 2M $\Sigma \bar{I}_y = 6.31 \times 10^6\ mm^4$ → $\bar{I}_x = 9.841 \times 10^6\ mm^4$ . . . . 2M $(\bar{x} = 57.42\ mm,\ \bar{y} = 52.14 mm)$ → $K_x = 48.406\ mm$ . . . 2M (least K)	12M

Module-4 : Centroid and Moment of Inertia

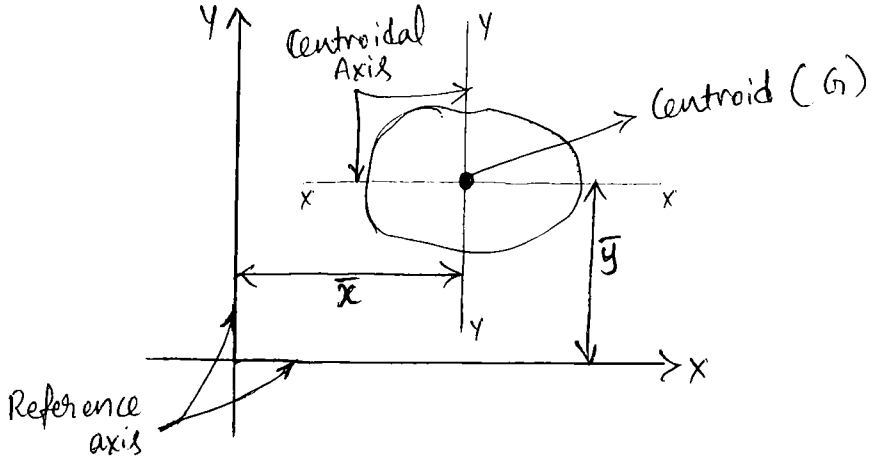
CENTROID

Centre of gravity : It is the point at which the total weight of the body is assumed to be concentrated.

(or)

It is the point at which the total weight of the body is assumed to be balanced.

Centroid : A centroid is the point at which the whole area of the plane figure is assumed to be concentrated.



Centroid of plane figure :

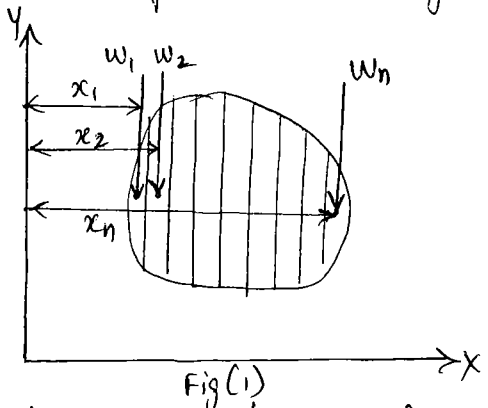


Fig (1)

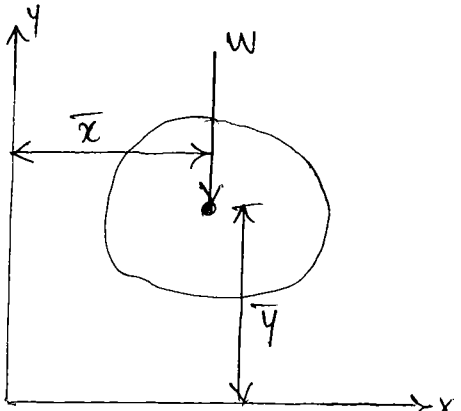


Fig (2)

Consider a plane fig. on x-y plane as shown in fig. Let it is divided into no. of small elements as shown in fig (1). The co-ordinate of resultant of all the forces is $\bar{x}$ & $\bar{y}$ as shown in fig (2).

According to Varignon's theorem. the moment of resultant about any axis is equal to the sum of moments of individual forces about the same axes.

Consider a moment about y- axis.

$$W\bar{x} = w_1x_1 + w_2x_2 + w_3x_3 + \dots + w_nx_n \rightarrow (1)$$

$W = \rho V$, where ρ = Density, V = volume = $A \times t$

$\therefore W = \rho (A \times t)$

$W = \rho A t$

Assume the density and thickness is uniform throu -gh out.

From eqn (1) $(\rho A t)\bar{x} = (\rho A_1 t)x_1 + (\rho A_2 t)x_2 + (\rho A_3 t)x_3 + \dots + (\rho A_n t)x_n$

$\rho t A\bar{x} = \rho t [A_1x_1 + A_2x_2 + A_3x_3 + \dots + A_nx_n]$

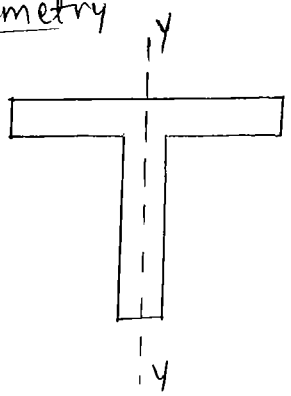
$A\bar{x} = A_1x_1 + A_2x_2 + A_3x_3 + \dots + A_nx_n$

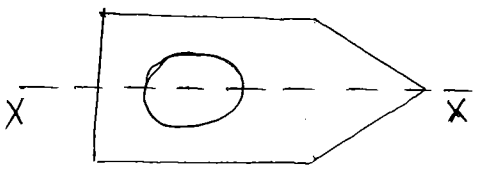
$A\bar{x} = \sum_{n=1}^{n} A_nx_n$

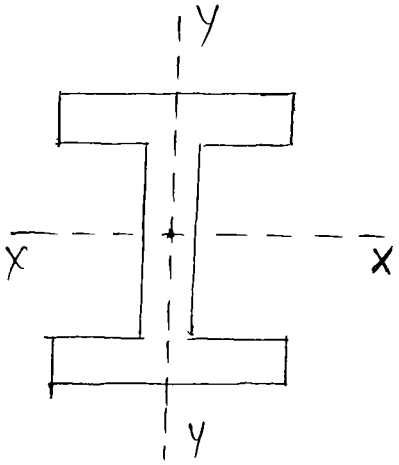
$\bar{x} = \dfrac{\sum_{n=1}^{n} A_nx_n}{A}$ $\therefore$ $\boxed{\bar{x} = \dfrac{\int x\,da}{A}}$

IIIly $\bar{y} = \dfrac{\sum_{n=1}^{n} A_ny_n}{A}$ $\therefore$ $\boxed{\bar{y} = \dfrac{\int y\,da}{A}}$

Axis of Symmetry :- It is an axis which divides the area into two equal parts such that each part is mirror image of the other is called "Axis of Symmetry"







Note :-

i) If the diagram is symmetrical about x-axis then $\bar{y} = 0$

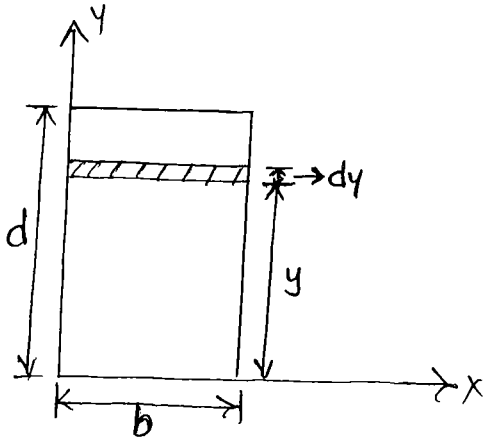
ii) If the diagram is symmetrical about y-axis then $\bar{x} = 0$

Centroid of Regular Geometrical Figures

1) Rectangle :-

Consider a rectangle of breadth 'b' and depth 'd' on x - y plane as shown in fig.

Let us consider an elemental area "da" of width "b" and depth "dy" at a distance "y" from the x- axis.



Elemtal area = $da = b \times dy$

W.K.T $\bar{y} = \dfrac{\int y \cdot da}{A}$

$A\bar{y} = \int y\, da$

$= \int_0^d y\, b\, dy$

$= b\int_0^d y\, dy$

$= b\left[\dfrac{y^2}{2}\right]_0^d$

$A\bar{y} = \dfrac{bd^2}{2}$

$b \times d\, \bar{y} = \dfrac{bd^2}{2}$

$\therefore \boxed{\bar{y} = \dfrac{d}{2}}$

Area of Rectangle
$A = b \times d$
$da = b \times dy$

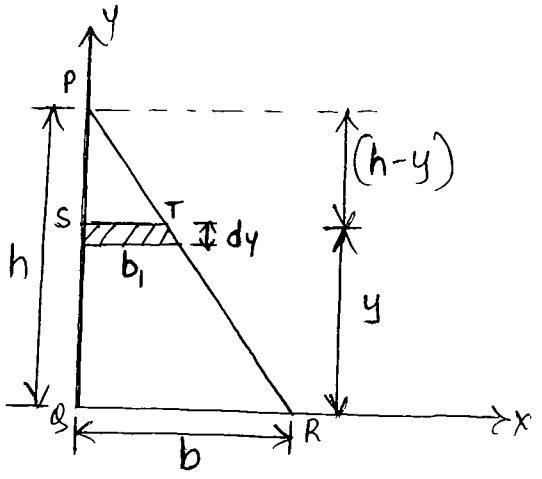
III^ly $\boxed{\bar{x} = \dfrac{d}{2}}$

2) Triangle

i) Right angle triangle

Consider a right angle Δ^{le} of base 'b' and height 'h' on xy plane as shown in fig.

Let us consider an elemental area of width b_1 and depth 'dy' at a distance y from the base (y- axis)



From similar Δ^{les} PQR & PST

$$\frac{b_1}{h-y} = \frac{b}{h}$$

$$\therefore b_1 = \frac{b(h-y)}{h}$$

Elemental area, $da = b_1 \times dy$

$$\therefore da = \frac{b(h-y)}{h} dy$$

Area of triangle, $A = \frac{1}{2} \times b \times h$

W.K.T, $\bar{y} = \frac{\int y\, da}{A}$

$$A\bar{y} = \int_0^h y \frac{b(h-y)}{h} dy$$

$$A\bar{y} = \frac{b}{h}\left[\int_0^h yh - \int_0^h y^2\right] dy$$

$$= \frac{b}{h}\left[\frac{hy^2}{2}\right]_0^h - \left[\frac{y^3}{3}\right]_0^h$$

$$= \frac{b}{h}\left[\frac{h^3}{2} - \frac{h^3}{3}\right]$$

$$A\bar{y} = \frac{bh^3}{6}$$

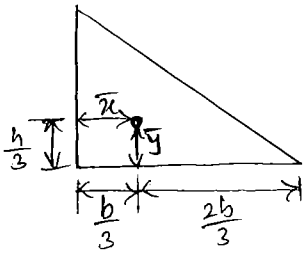
$$A\bar{y} = \frac{bh^2}{6}$$

$A = \frac{1}{2} \times b \times h$

$$\frac{1}{2} \times b \times h \times \bar{y} = \frac{bh^2}{6}$$

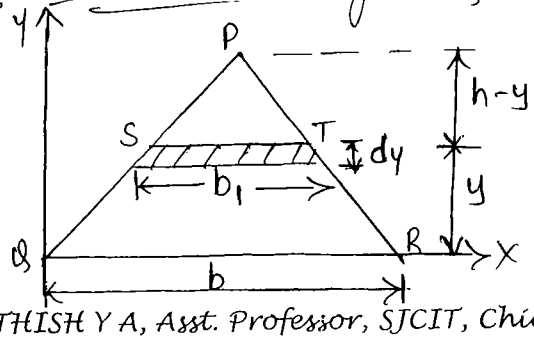
$$\bar{y} = \frac{2h}{6} = \frac{h}{3}$$

$$\therefore \boxed{\bar{y} = \frac{h}{3}}$$



^{ly} $\boxed{\bar{x} = \frac{b}{3}}$

ii) Isosceles Tringle & Equilateral triangle



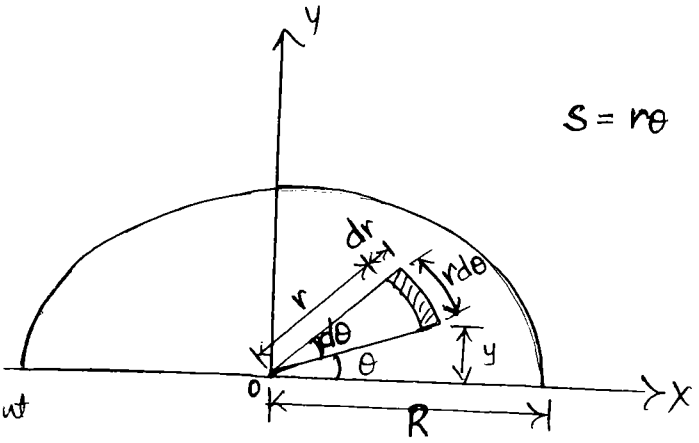
** Derivation part is same **

$$\therefore \boxed{\bar{y} = \frac{h}{3}} \quad \text{but} \quad \boxed{\bar{x} = \frac{b}{2}}$$

3) Semi circle

Consider a semicircle of radius 'R' which is symmetrical about y-axis as shown in fig.

Let us consider an elemental area of sides $r d\theta$ & dr at a distance 'r' from O.



Semi circle is symmetrical about y-axis $\therefore \boxed{\bar{x} = 0}$

$$\sin\theta = \frac{y}{r}$$

$$\boxed{y = r\sin\theta}$$

Elemental area $= da = r d\theta \times dr$ | Area of Semi circle, $A = \frac{\pi R^2}{2}$

W.K.T., $\bar{y} = \frac{\int y\, da}{A}$

$$A\bar{y} = \int_0^{\pi}\int_0^{R} y\, r d\theta\, dr$$

$$A\bar{y} = \int_0^{\pi}\int_0^{R} r\sin\theta\, r d\theta\, dr = \int_0^{\pi}\int_0^{R} r^2 \sin\theta\, d\theta\, dr$$

$$A\bar{y} = \int_0^{\pi} \sin\theta\, d\theta \int_0^{R} r^2 dr$$

$$= \int_0^{\pi} \sin\theta\, d\theta \left[\frac{r^3}{3}\right]_0^{R} = \int_0^{\pi} \left[\frac{R^3}{3}\right] \sin\theta\, d\theta$$

$$= \frac{R^3}{3}\int_0^{\pi} \sin\theta\, d\theta = \frac{R^3}{3}\left[-\cos\theta\right]_0^{\pi}$$

$$= \frac{R^3}{3}\left[-\cos\pi + \cos 0\right]$$

$$= \frac{R^3}{3}\left[1 + 1\right] = \frac{2R^3}{3}$$

$$A\bar{y} = \frac{2R^3}{3}$$

$$\frac{\pi R^2}{2}\bar{y} = \frac{2R^3}{3}$$

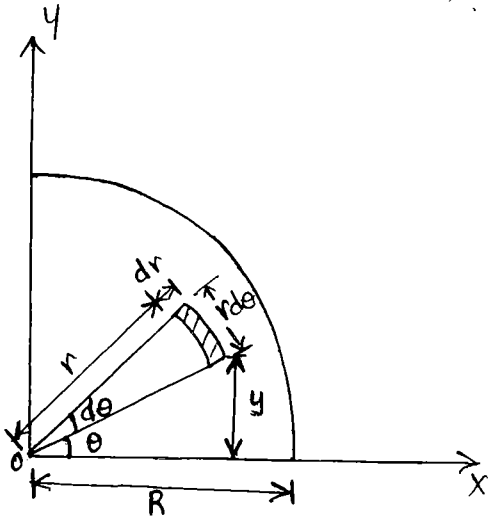
$$\therefore \boxed{\bar{y} = \frac{4R}{3\pi}} \quad \& \quad \boxed{\bar{x} = 0}$$

| $A = \frac{\pi R^2}{2}$

4) Quarter Circle

Consider a quarter circle of a circle of radius 'R' (which is not symmetrical about any axis) on x-y plane as shown in fig.

Let us consider an elemental area of sides rdθ & dr at a distance of 'r' from O.



$$\sin\theta = \frac{y}{r}$$

$$\boxed{y = r\sin\theta}$$

Elemental area, $da = r\,d\theta \times dr$ | Area of quarter circle, $A = \frac{\pi R^2}{4}$

W.K.T,

$$\bar{y} = \frac{\int y\,da}{A}$$

$$A\bar{y} = \int_0^{\pi/2}\int_0^{R} r\sin\theta \times r\,d\theta \times dr$$

$$= \int_0^{\pi/2}\int_0^{R} r^2\sin\theta\,d\theta\,dr$$

$$= \int_0^{\pi/2}\sin\theta\,d\theta \int_0^{R} r^2 dr = \int_0^{\pi/2}\sin\theta\,d\theta \left[\frac{r^3}{3}\right]_0^{R}$$

$$= \int_0^{\pi/2}\sin\theta\,d\theta \left[\frac{R^3}{3}\right] = \frac{R^3}{3}\int_0^{\pi/2}\sin\theta\,d\theta$$

$$= \frac{R^3}{3}\left[\cos\theta\right]_0^{\pi/2}$$

$$= \frac{R^3}{3}\left[\cos\frac{\pi}{2} - \cos 0\right] = \frac{R^3}{3}\left[0 - (-1)\right]$$

$$A\bar{y} = \frac{R^3}{3}[1)$$

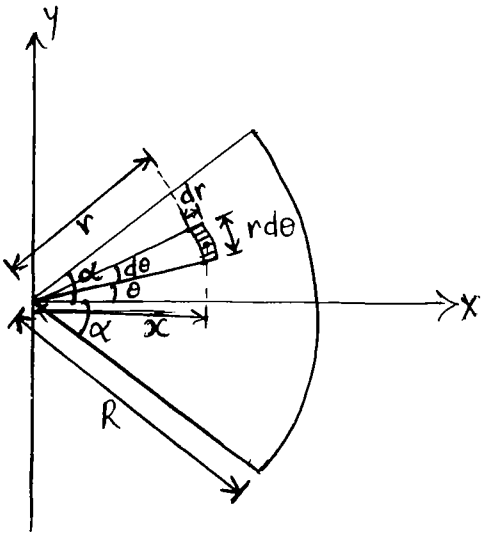
| $A = \frac{\pi R^2}{4}$

$$\frac{\pi R^2}{4} \times \bar{y} = \frac{R^3}{3}$$

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

III^{ly} $\boxed{\bar{x} = \frac{4R}{3\pi}}$

5) Sector :



Consider a sector of a circle symmetrical about x-axis, as shown in fig.

Let us consider an elemental area of sides $rd\theta$ & dr at a distance of r from O

$$\cos\theta = \frac{x}{r}$$

$$\boxed{x = r\cos\theta}$$

As fig is symm// about x-axis

$$\therefore \boxed{\bar{y} = 0}$$

Elemental area $= \boxed{da = rd\theta \times dr}$

W.K.T, $\quad \bar{x} = \dfrac{\int x\, da}{A}$

$$A\bar{x} = \int x\, da$$

$$= \int_{-\alpha}^{\alpha}\int_{0}^{R} (r\cos\theta)\,(rd\theta \times dr)$$

$$A\bar{x} = \int_{-\alpha}^{\alpha}\int_{0}^{R} (r^2 dr)\,(\cos\theta\, d\theta)$$

$$A\bar{x} = \left[\frac{r^3}{3}\right]_0^R \left[\sin\theta\right]_{-\alpha}^{\alpha}$$

$$= \frac{R^3}{3} \times \left[\sin\alpha - (\sin -\alpha)\right]$$

$$= \frac{R^3}{3}\left[\sin\alpha + \sin\alpha\right]$$

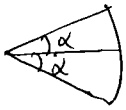
$$\boxed{A\bar{x} = \frac{R^3}{3}\, 2\sin\alpha} \longrightarrow (i)$$

Area of a sector of an included angle α is

$$A = \frac{R^2\theta}{2}$$

θ = Total angle

$$\therefore \boxed{\theta = 2\alpha}$$

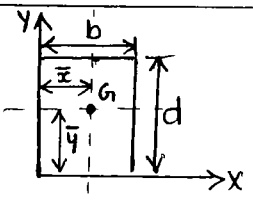
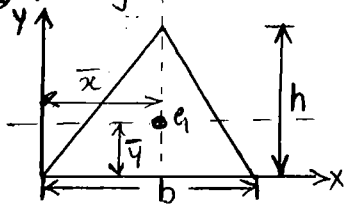
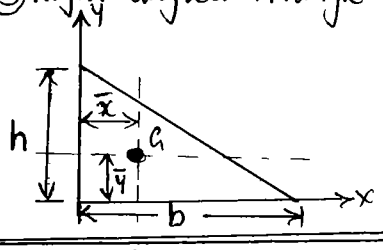
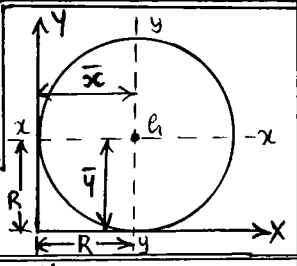
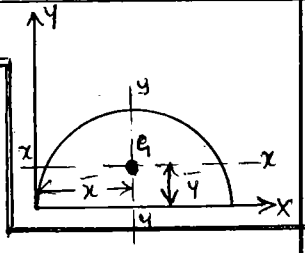
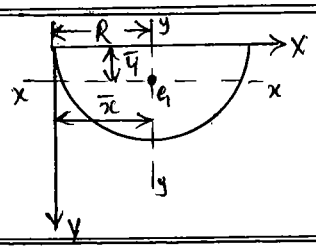
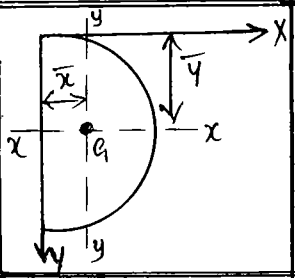
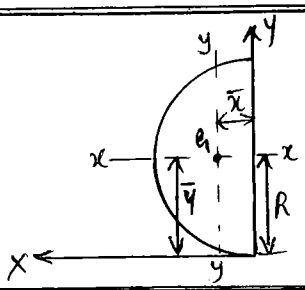
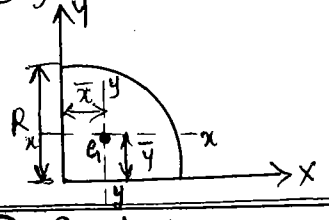
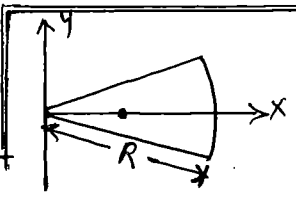


$$A = \frac{R^2\, 2\alpha}{2}$$

$$\therefore \boxed{A = R^2\alpha}$$

$$\therefore \quad R^2\alpha \times \bar{x} = \frac{R^3}{3} 2\sin\alpha$$

$$\therefore \quad \boxed{\bar{x} = \frac{2R\sin\alpha}{3\alpha}} \qquad \& \qquad \boxed{\bar{y} = 0}$$

Shape and Figure	Area	$\bar{x}$	$\bar{y}$
① Rectangle (same for square) 	bd	$\frac{b}{2}$	$\frac{d}{2}$
② Triangle 	$\frac{1}{2}bh$	$\frac{b}{2}$	$\frac{h}{3}$
③ Right angled triangle 	$\frac{1}{2}bh$	$\frac{b}{3}$	$\frac{h}{3}$
④ Circle 	πR^2	R	R
⑤ Semi circle (a) 	$\frac{\pi R^2}{2}$	R	$\frac{4R}{3\pi}$
(b) 	$\frac{\pi R^2}{2}$	R	$\frac{-4R}{3\pi}$
(c) 	$\frac{\pi R^2}{2}$	$\frac{4R}{3\pi}$	$-R$
(d) 	$\frac{\pi R^2}{2}$	$-\frac{4R}{3\pi}$	R
⑥ Quarter circle 	$\frac{\pi R^2}{4}$	$\frac{4R}{3\pi}$	$\frac{4R}{3\pi}$
⑦ Sector 	$R^2\alpha$	$\frac{2R\sin\alpha}{3\alpha}$	0

Moment of Inertia

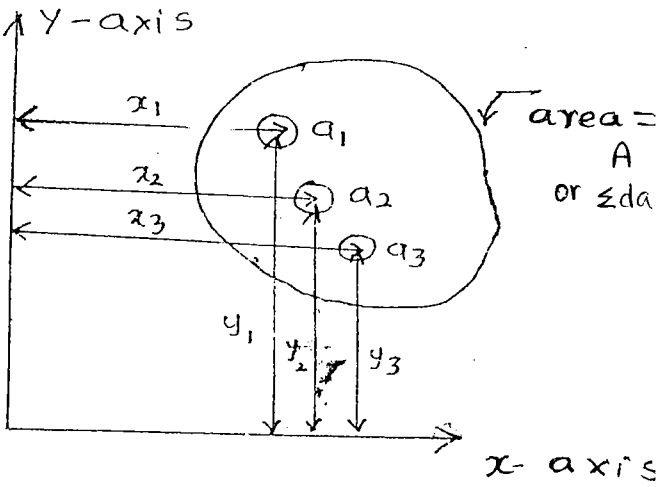
The secondary moment of the area of the lamina about an axis is called as 'Moment of Inertia'. It can also be defined as 'moment of the "moment of area" about an axis'. It is denoted as I. Moment of Inertia is one of the property of structural members such as beams, columns etc..

Moment of Inertia of a uniform lamina:-

Let us considered a lamina of area A as shown in fig. Let us divide the area of the lamina into components of area $a_1, a_2, a_3 \cdots$

Let $x_1, x_2, x_3 \cdots$ etc are be the centroidal distances of the areas $a_1, a_2, a_3 \cdots$ etc. from y-axis

and $y_1, y_2, y_3 \cdots$ etc are be the centroidal distances of the areas $a_1, a_2, a_3 \cdots$ etc from x-axis.



Then moment of inertia of the components of the areas about y-axis

$$I_{y\text{-axis}} = a_1x_1^2 + a_2x_2^2 + a_3x_3^2 + \cdots \text{etc}$$

$$= \Sigma ax^2$$

$$\therefore I_{Y\text{axis}} = \Sigma ax^2$$

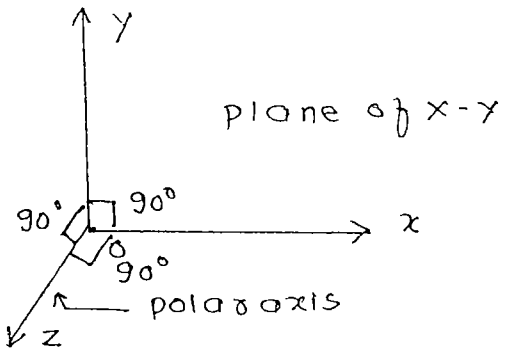
Similarly

$$I_{x\text{-axis}} = \Sigma ay^2$$

Note: Moment of Inertia of the lamina found about centroidal x-x and centroidal y-y axis, are denoted as I_{x-x} and I_{y-y} respectively.

Polar axis:

Polar axis is the axis which passess through the origin of x and y axis in such a way that plane of x and y axis is perpendicular to that axis.



Polar moment of Inertia:

If the moment of Inertia of the lamina found about polar axis, then it is called as polar moment of Inertia and it is denoted as I_p. If the z-axis is the polar axis, then the moment of inertia is called as polar moment of Inertia and is denoted as I_{z-z}.

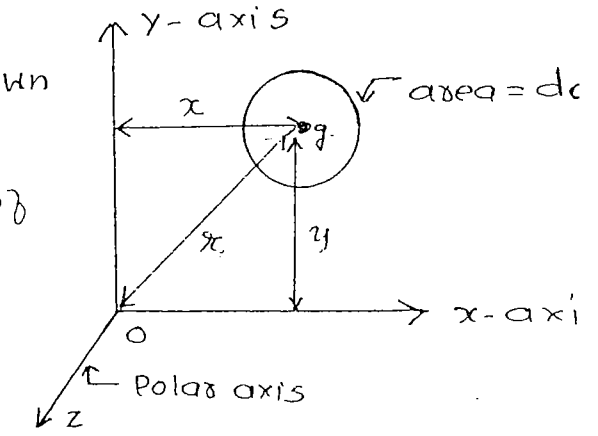
Perpindicular axis theorem:-

Statement: This theorem states that "polar moment of Inertia of a lamina is equal to sum of the moment of Inertia about x and y axis".

Mathematically

$$I_p = I_{z-z} = I_{x-x} + I_{y-y}$$

Proof: Let us consider a lamina of area da as shown in fig. Let x and y are be the co-ordinates of the centre of the area da.



Moment of Inertia of the lamina about y-axis

$I_{y\text{-}axis}$ = area x (centroidal distance)^2

$I_{y-y} = da x^2$

Moment of Inertia of the lamina about x-axis

$$I_{x\text{-axis}} = da \cdot y^2$$

or $$I_{x-x} = day^2$$

Let 'r' be the distance of the centre of the lamina from polar axis or from the origin of x and y-axis.

Then, Moment of Inertia of the lamina about polar axis

$$I_p = dar^2$$

$$Ip = I_{Z-Z} = dar^2$$

From the Geometry of the fig

$$r^2 = x^2 + y^2$$

$$\therefore I_{Z-Z} = da(x^2+y^2)$$

$$= dax^2 + day^2$$

$$= I_{y-y} + I_{x-x}$$

$$\therefore \boxed{I_p = I_{Z-Z} = I_{x-x} + I_{y-y}}$$

***

Parallel axis theorem:-

Statement: This theorem states that " moment of Inertia of a lamina (ie plane area) about any axis is equal to sum of the moment of Inertia about the centroidal axis [This axis should be parallel to the axis about which moment of inertia to be found] plus the product of the area of the lamina and the square of the distance between the centroidal axis and the axis about which moment of inertia to be found ".

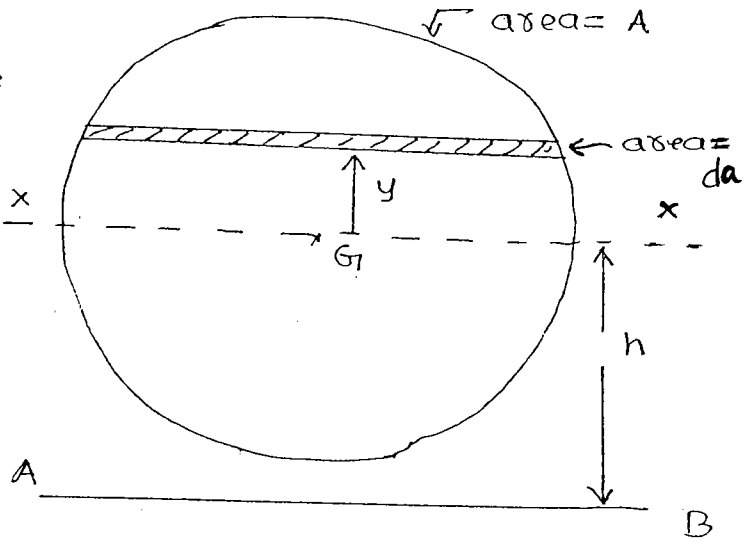
Mathematically,

$$I_{any\ axis} = I_G + Ah^2$$

Where I_G = Moment of Inertia of the lamina about centroidal axis

Proof :- Consider a lamina of arbitoary shape of area A as shown in fig. Let G be the centroid of the area. Let x-x be the centroidal axis of the area.

consider a strip of area da placed parallel to centroidal x-x axis at a distance y from it. Let AB be the axis parallel to the centroida axis x-x at a distance 'h' from x-x about which moment of Inertia to be found.



Moment of Inertia of the strip about x-x axis

= area of the strip x Distance^2 x

= $da \cdot y^2$

∴ Moment of the Inertia of the whole lamina about x-x

$I_{x-x} = \Sigma day^2$

$I_{x-x} = I_G = \Sigma day^2 \longrightarrow (1)$

Similarly, Moment of Inertia of the area of the strip about an axis AB

= area of the strip x Distance^2

= $da\,(h+y)^2$

∴ Moment of Inertia of the whole lamina about an axis AB

$I_{AB} = \sum da(h+y)^2$

$= \Sigma\ da(h^2+y^2+2hy)$

$= \Sigma dah^2 + \Sigma day^2 + \Sigma da \cdot 2hy \longrightarrow (2)$

$I_{AB} = h^2 \Sigma da + \Sigma day^2 + 2h \Sigma day$

Where $h^2 \Sigma da = h^2 A = Ah^2$ ∵ $\Sigma da = A$

$\Sigma day^2 = I_G = I_{x-x}$ from eqn (1)

and Σday = Moment of the whole area about the centroidal axis x-x

W.k.t $\frac{\Sigma day}{\Sigma a} = \bar{y} = 0$ for the present case

which means $\Sigma day = 0$

Substituting the values of $h^2 \Sigma da$, Σday^2 and $2h \Sigma da$ in the eqn (2), We get

$$I_{AB} = Ah^2 + I_{x-x} + 0$$

OR $$\boxed{I_{AB} = I_{G_1} + Ah^2}$$ $\because I_{x-x} = I_{G_1}$

Note: Moment of inertia of a lamina about an axis passing through the centroid is denoted as I_{G_1}.

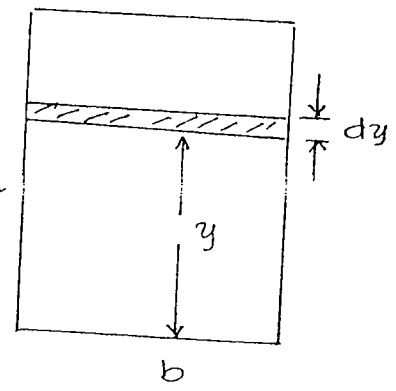
Now

Moment of Inertia of various geometrical Sections

1. Moment of Inertia of a Rectangular section.

Consider a Rectangular lamina of base 'b' and of depth 'd' as shown in fig.

Consider a strip of thickness 'dy' placed parallel to the base at a distance 'y' from it.



Moment of inertia of the strip about the base of rectangle

= area of strip × distance^2

= $(b \cdot dy) \cdot y^2$

Moment of inertia of the whole rectangle about the base

$$I_{base} = \int_0^d (b \cdot dy) \cdot y^2 = b \int_0^d y^2 \, dy = b \left[\frac{y^3}{3}\right]_0^d$$

$$= \frac{b}{3}\left[d^3 - 0\right] = \frac{bd^3}{3}$$

$$I_{base} = \frac{bd^3}{3}$$

Moment of inertia of the rectangular section about its centroidal axis can be found using parallel axis theorem which says

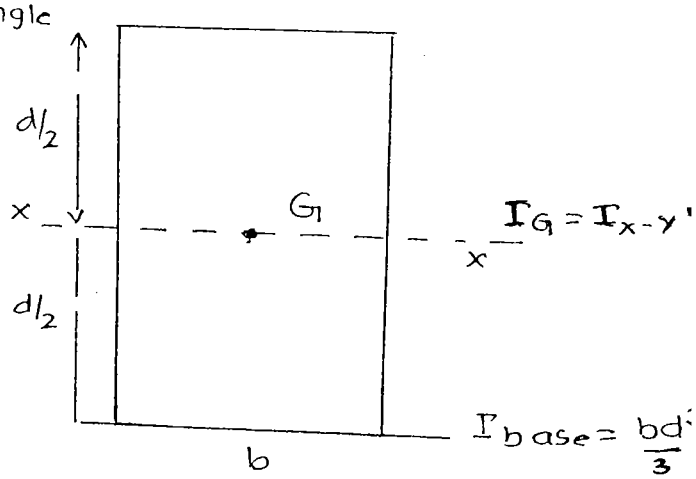
$$I_{any\ axis} = I_{G_1} + Ah^2$$

Where any axis = base of rectangle

I_{G_1} = I_{x-x} of the rectangle = ?

A = area of rectangle = bd

h = Distance b/n x-x axis and base of rectangle = $d/2$



$$I_{base} = I_{x-x} + Ah^2$$

$$\frac{bd^3}{3} = I_{x-x} + bd\left(\frac{d}{2}\right)^2$$

$$= I_{x-x} + \frac{bd^3}{4}$$

$$I_{x-x} = \frac{bd^3}{3} - \frac{bd^3}{4}$$

$$= \frac{4bd^3 - 3bd^3}{12}$$

$$\boxed{I_{x-x} = \frac{bd^3}{12}}$$

Illly,

$$\boxed{I_{y-y} = \frac{db^3}{12}}$$

Radius of Gyration (K)

It is defined as that distance from a given axis upto a point where the entire area is assumed to be concentrated

$$K = \sqrt{\frac{I}{A}}$$

Radius of gyration about x-x axis

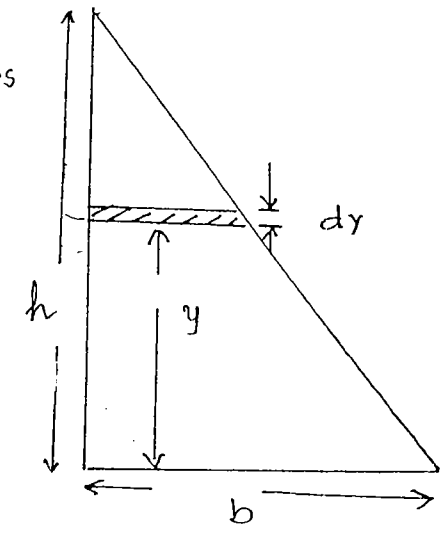
$$K_{x-x} = \sqrt{\frac{I_{x-x}}{A}}$$

Radius of gyration about y-y axis

$$K_{y-y} = \sqrt{\frac{I_{y-y}}{A}}$$

2. Moment of Inertia of a triangular lamina.

Consider a right angled triangle of base 'b' and of height 'h'. Let us consider a rectangular strip of thickness 'dy' placed parallel to the base at a distance 'y' from it, as shown in fig.



Width of the strip $= \frac{b}{h}(h-y)$ from similar property of triangles

Area of strip = width × thickness

$= \frac{b}{h}(h-y)\cdot dy$

∴ Moment of Inertia of the strip about the base of triangle

= Area of strip × Distance^2

$= \frac{b}{h}(h-y)\cdot dy \cdot y^2$

Moment of Inertia of the whole triangle about the base can be found by integrating the above eqn b/n the limits 0 to h.

$$I_{base} = \int_0^h \frac{b}{h}(h-y)\cdot dy\cdot y^2 = \frac{b}{h}\int_0^h (hy^2 - y^3)\,dy$$

$$= \frac{b}{h}\left[\frac{h\cdot y^3}{3} - \frac{y^4}{4}\right]_0^h$$

$$= \frac{b}{h}\left[\frac{h\cdot h^3}{3} - \frac{h^4}{4}\right]$$

$$= \frac{b}{h}\left[\frac{h^4}{3} - \frac{h^4}{4}\right] = \frac{b}{h}\left[\frac{4h^4 - 3h^4}{12}\right]$$

$$= \frac{b}{h}\times\frac{h^4}{12} = \frac{bh^3}{12}$$

∴ Moment of Inertia of the triangle about its base $= I_{base} = \frac{bh^3}{12}$

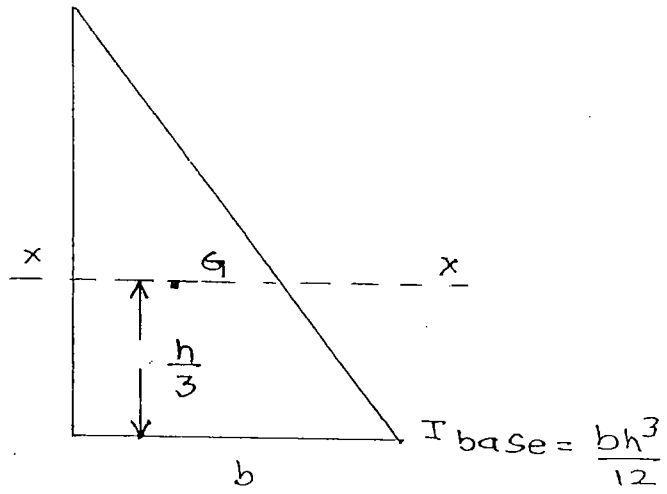
Moment of Inertia of a triangle about its centroidal axis can be found by making use of parallel axis theorem which says

$$I_{\text{anyaxis}} = I_G + Ah^2$$

where I_G = M.O.I. of a triangle about centroidal axis.

A = area of the triangle $= \frac{1}{2} \cdot b \cdot h$.

h = Distance b/n the centroidal axis and reference axis (ie base) $= \frac{h}{3}$



$$\therefore I_{\text{anyaxis}} = I_G + Ah^2$$

$$I_{\text{base}} = I_{x-x} + Ah^2$$

$$\frac{bh^3}{12} = I_{x-x} + \frac{bh}{2}\left(\frac{h}{3}\right)^2$$

$$= I_{x-x} + \frac{bh^3}{18}$$

$$\therefore I_{x-x} = \frac{bh^3}{12} - \frac{bh^3}{18}$$

$$= \frac{3bh^3 - 2bh^3}{36}$$

$$\boxed{I_{x-x} = \frac{bh^3}{36}}$$

this is M.O.I. of the triangle about its centroidal axis.

Note:

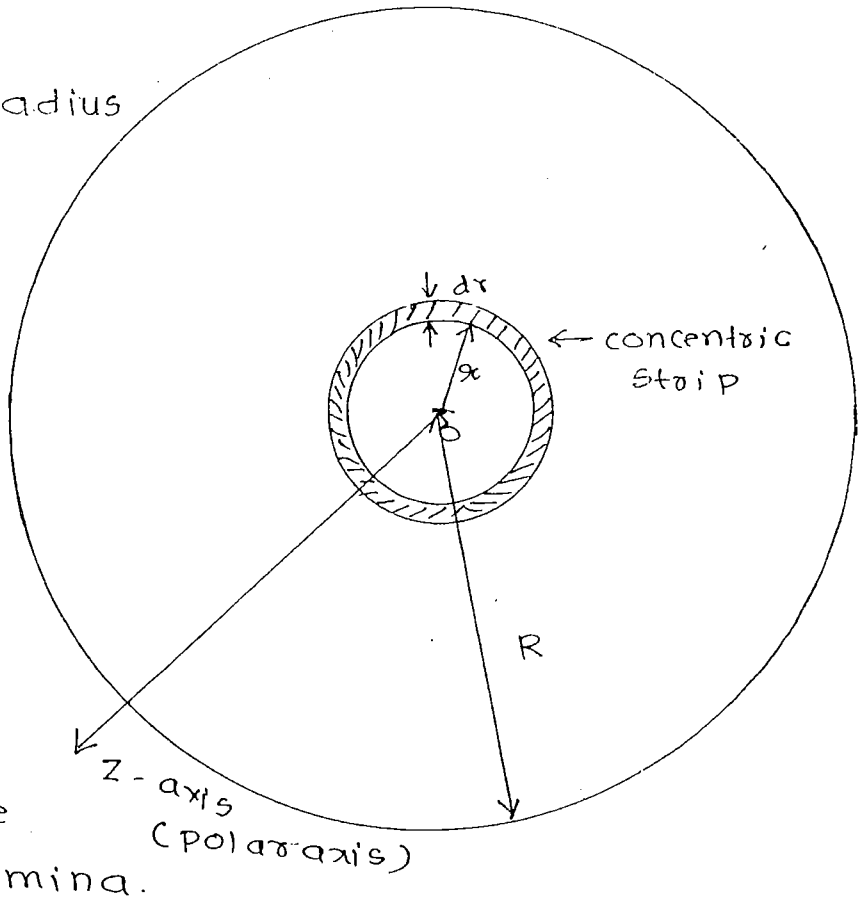
1. M.O.I of a triangle about its base $= \frac{bh^3}{12}$

2. M.O.I of a triangle about its centroidal axis $= \frac{bh^3}{36}$

3. Moment of Inertia of a circular sections:-

3.1. M.O.I of a circle

Consider a circular lamina of radius 'R'. Let us consider a circular concentric ring of thickness 'dr' at a distance 'r' from the centre of the circular lamina.



Consider Z axis (ie polar axis) through the centre of the circle (ie O) ⊥r to the plane of area of circular lamina.

then area of the elemental ring $= 2\pi r \cdot dr$

M.O.I of the ring about Z-axis (ie polar axis) is

$$= \text{area of the ring} \times \text{Distance}^2$$

$$= 2\pi r \cdot dr \cdot r^2$$

$$= 2\pi r^3 dr$$

∴ M.O.I of the whole circular lamina about Z-axis can be found by integrating the above eqn b/n the limits 0 to R.

$$I_{\text{Polar axis}} = I_Z = \int_0^R 2\pi r^3 dr = 2\pi \int_0^R r^3 dr$$

$$= 2\pi \left[\frac{r^4}{4}\right]_0^R$$

$$= \frac{2\pi}{4}\left[R^4 - 0\right]$$

$$I_{\text{Polar axis}} = \frac{\pi R^4}{2} = I_{Z\text{-axis}}$$

But from $\perp^r$ axis theorem we know that

$$I_{\text{Polar axis}} = I_{z-z} = I_{x-x} + I_{y-y}$$

If a lamina is symmetrical about both axis and all 4 areas are equal, then $I_{x-x} = I_{y-y}$. Since circular section is symmetrical about both the axis and also all 4 areas are equal, then its I_{x-x} and I_{yy} values are equal

$$\therefore \quad I_p = I_z = I_{x-x} + I_{yy}$$

$$= 2 I_{x-x} \quad \because I_{x-x} = I_{y-y}$$

$$\frac{\pi R^4}{2} = 2 I_{x-x}$$

$$\therefore \quad \boxed{I_{x-x} = \frac{\pi R^4}{4} = I_{y-y}}$$

3.2 Moment of inertia of Semi-circular lamina:

M.O.I of a semi-circular lamina can be found by making use of parallel axis theorem which says

$$I_{\text{any axis}} = I_G + Ah^2$$

Where I_G = M.O.I of a semicircle about its centroidal axis (say x-x axis)

A = area of semicircle $= \frac{\pi R^2}{2}$

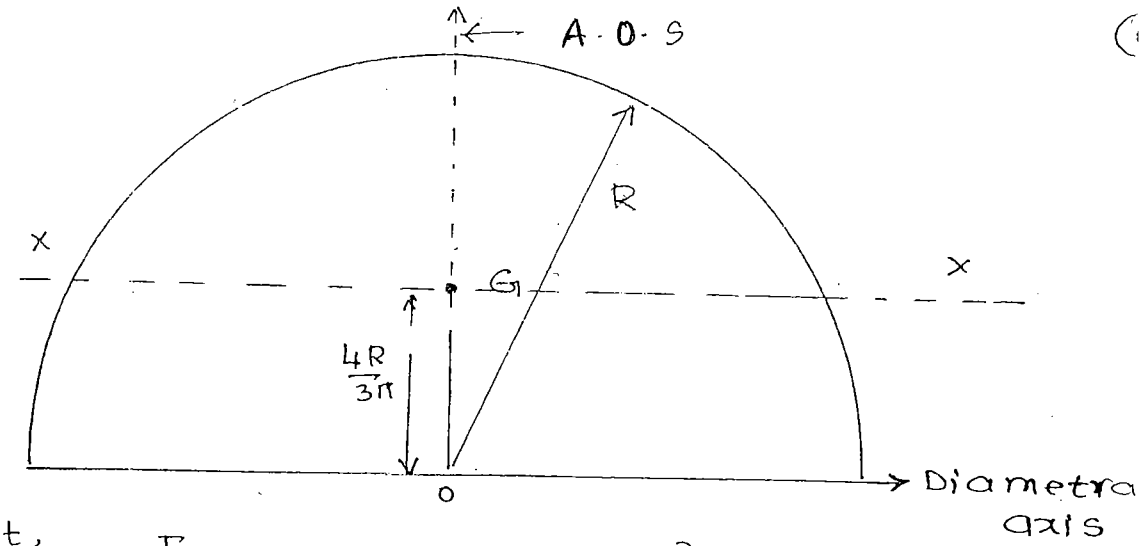
h = Distance b/n the centroidal axis (x-x) and reference axis (say base of semi-circle)

$$= \frac{4R}{3\pi}$$

M.O.I. of circle about its centroidal x-x axis

$$= \frac{\pi R^4}{4}$$

then M.O.I of Semi-circle about the **diametraic** axis (ie. **base of semi-circle**) $= \frac{\pi R^4}{8}$



Wkt, $I_{any\ axis} = I_G + Ah^2$

Let any axis be the diametral axis where the M.O.I of semicircle is $\frac{\pi R^4}{8}$

$$\therefore I_{Diametral\ axis} = I_{x-x} + Ah^2$$

$$\frac{\pi R^4}{8} = I_{x-x} + \frac{\pi R^2}{2}\left(\frac{4R}{3\pi}\right)^2$$

$$= I_{x-x} + \frac{16\pi R^4}{18\pi^2}$$

$$= I_{x-x} + \frac{16R^4}{18\pi}$$

$$I_{x-x} = \frac{\pi R^4}{8} - \frac{16R^4}{18\pi}$$

$$= R^4\left[\frac{\pi}{8} - \frac{16}{18\pi}\right]$$

$$= R^4(0.1097)$$

$$\boxed{I_{x-x} = 0.11R^4} \quad \because 0.1097 \simeq 0.11$$

$I_{y-y} = \frac{\pi R^4}{8}$ = M.O.I of semicircle about its centroidal y-y axis

NOTE:

The values of I_{x-x} and I_{y-y} for a semicircle are not constant. If the diametral axis of a semicircle is horizontal then $I_{x-x} = 0.11R^4$ and $I_{y-y} = \frac{\pi R^4}{8}$. $I_{yy}=0.11R^4$

If the diametral axis is vertical, then $I_{x-x} = \pi R^4/8$ and

3.3. M.O.I of a quarter of a circle :

Let us consider the quadrantic of radius 'R' as shown in fig. The M.O.I of a quadrant about its centroidal axis can be found by using parallel axis theorem

$$\therefore \quad I_{anyaxis} = I_G + Ah^2$$

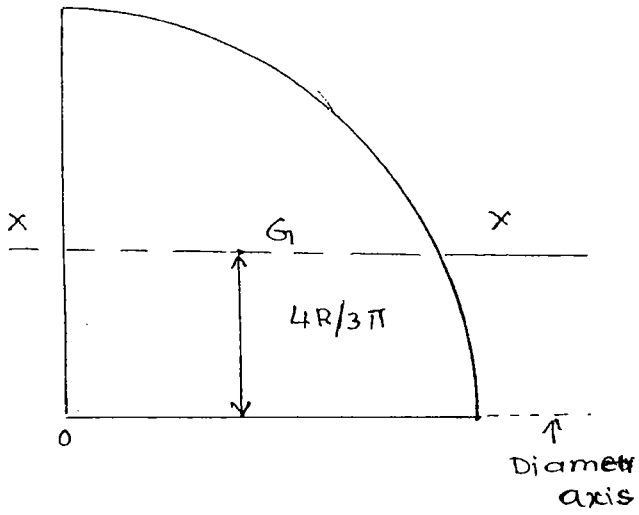
Where I_G = M.O.I of a quadrant about its centroidal axis (say x-x)

A = Area of quadrant

$$= \frac{\pi R^2}{4}$$

h = Distance b/n the centroidal axis (x-x) and the reference axis (say diametral axis)

$$= \frac{4R}{3\pi}$$



M.O.I of a circle about its centroidal x-x $= \frac{\pi R^2}{4}$

$\therefore$ Moment of Inertia of quadrant about the same axis (ie Diametral axis)

$$= \frac{\pi R^4}{16}$$

W.K.T.

$$I_{anyaxis} = I_G + Ah^2$$

$$I_{\substack{Diametral \\ axis}} = I_{x-x} + Ah^2$$

$$\frac{\pi R^4}{16} = I_{x-x} + \frac{\pi R^2}{4}\left(\frac{4R}{3\pi}\right)^2$$

$$= I_{x-x} + \frac{16\pi R^4}{36\pi^2}$$

$$= I_{x-x} + \frac{16R^4}{36\pi}$$

$$\therefore \quad I_{x-x} = \frac{\pi R^4}{16} - \frac{16R^4}{36\pi}$$

$$= R^4\left[\frac{\pi}{16} - \frac{16}{36\pi}\right]$$

$$\therefore \quad I_{x-x} = R^4 (0.055)$$

$$I_{x-x} = 0.055 R^4$$

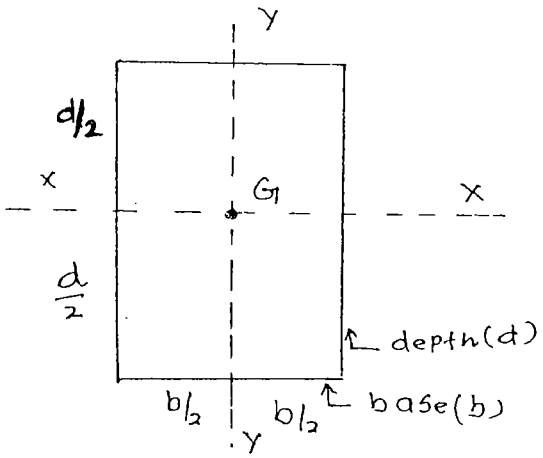
The value of I_{y-y} in case of a quadrant is same as I_{x-x}

$$\therefore \quad \boxed{I_{x-x} = I_{y-y} = 0.055 R^4}$$

~ o ~

NOTE

(1) For rectangular section:



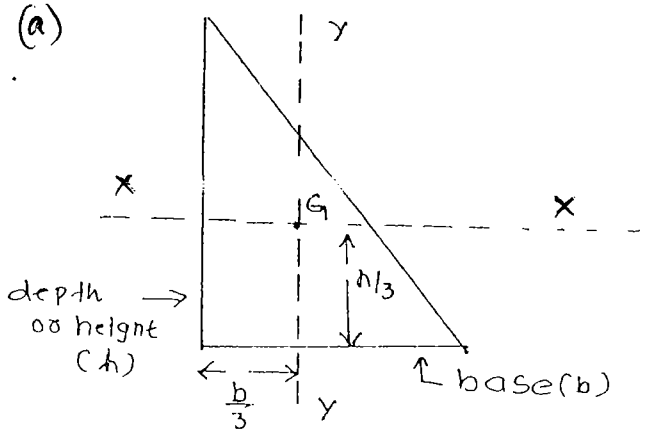
$$I_{base} = \frac{bd^3}{3}$$

$$I_{depth} = db^3/3$$

$$\boxed{I_{x-x} = \frac{bd^3}{12} \qquad I_{y-y} = db^3/12}$$

(2) For triangular section:

(a)

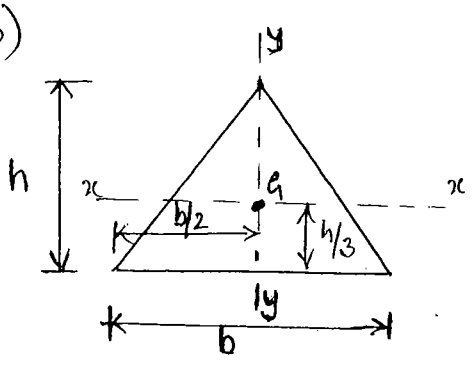


$$I_{base} = \frac{bh^3}{12}$$

$$I_{depth\ (height)} = \frac{hb^3}{12}$$

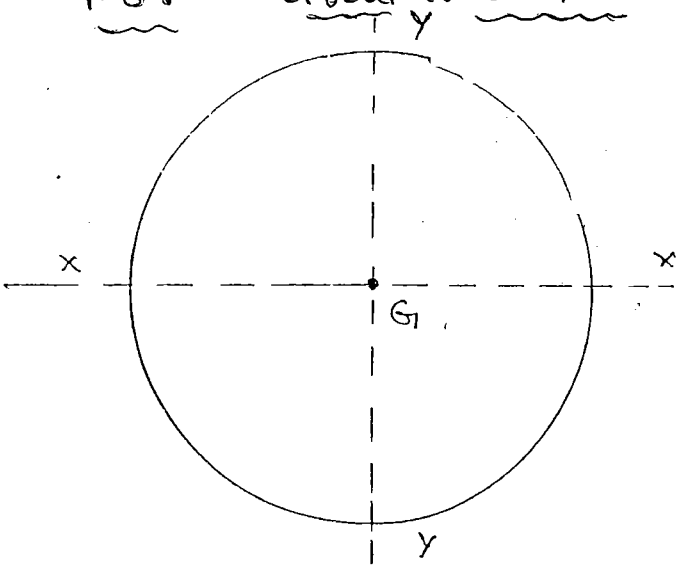
$$\boxed{I_{x-x} = \frac{bh^3}{36} \qquad I_{y-y} = hb^3/36}$$

(b)



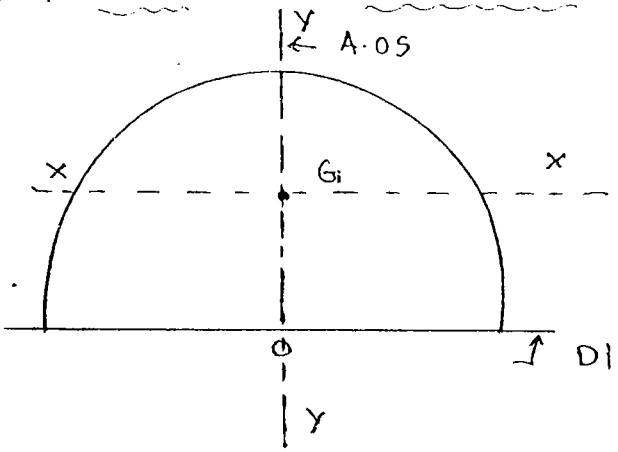
$$\boxed{I_{x-x} = \frac{bh^3}{36} \qquad I_{y-y} = \frac{hb^3}{48}}$$

(3) For circular section



$$I_{x-x} = I_{yy} = \frac{\pi R^4}{4}$$

(4). (i) For semi-circular section: (When the diametral axis is horizont



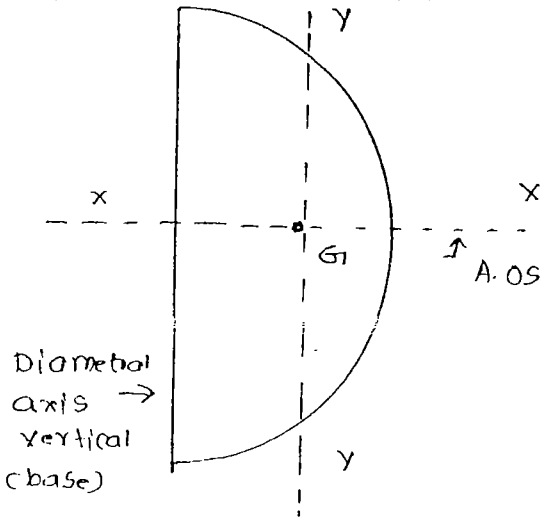
$$I_{base} = \frac{\pi R^4}{8}$$

$$I_{x-x} = 0.11 R^4$$

& $$I_{y-y} = \frac{\pi R^4}{8}$$

↑ Diametral axis is h3l (ie base of Sem circle

(ii) When the diametral axis is vertical:



$$I_{base} = \pi R^4/8$$

(ie D.A)

$$I_{x-x} = \pi R^4/8$$

$$I_{y-y} = 0.11 R^4$$

(5). For quadrant:

$$I_{\text{Diametral axis}} = I_{\text{base}} = \frac{\pi R^4}{16}$$

$$I_{x-x} = I_{yy} = 0.055 R^4$$

Note: The values of both I_{x-x} & I_{yy} are equal in the case of a circle and in quarter of a circle.