HAS (Mains) - 2021

This question paper contains 7 printed pages]

Roll Number

ASME-21-MEEG–(I)

MECHANICAL ENGINEERING (PAPER-I)

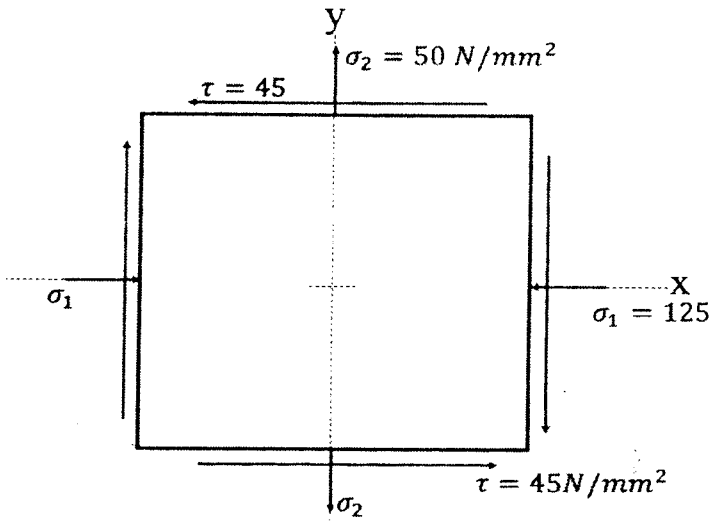
Time Allowed : 3 Hours] [Maximum Marks : 100

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

1. There are **EIGHT** questions printed in English.
2. Candidate has to attempt **FIVE** questions in all.
3. Question No. **1** is compulsory. Out of the remaining SEVEN questions, **FOUR** are to be attempted.
4. *All* questions carry equal marks. The number of marks carried by a question/part are indicated against it.
5. Write answers in legible handwriting.
6. Wherever any assumptions are made for answering a question, they must be clearly indicated.
7. Diagrams / Figures, wherever required, shall be drawn neatly. Unless otherwise mentioned, symbols and notations carry their usual standard meanings.
8. Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in answer book must be clearly struck off.
9. Re-evaluation/Re-checking of answer book of the candidate is not allowed.
10. Use of calculators is allowed.

1. (*a*) In a loaded structure, a plane stress condition exists at a point. Figure shows magnitude and directions of the stresses existing on the stress element. With the help of a sketch, calculate the stresses acting on the planes obtained after clockwise rotating the element through an angle of 19°. 10



(*b*) Explain the following theories of failure (using diagrams) : 4×2.5

(*i*) Maximum normal stress theory

(*ii*) Maximum shear stress theory

(*iii*) Maximum strain energy theory

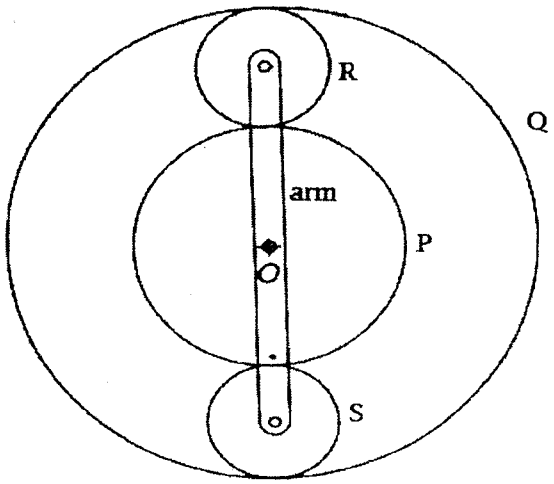
(*iv*) Maximum shear strain energy theory.

2. A fixed beam of length L has triangular loading with zero intensity at one end and w at the other end. Derive an expression for the fixed end moments and support reactions at both the ends. If length of the beam is 5 m & gradual loading varies from 0 kN/m to 40 kN/m; draw BM and SF diagrams for the beam. 20

3. (*a*) Figure below shows an epicyclic gear train in which the number of teeth on gear P & gear Q are 100 and 240 respectively. Determine the speed of arm under the following two conditions :

(*i*) Gear P rotates at speed of 100 rpm clockwise and gear Q rotates at a speed of 50 rpm counter clockwise.

(*ii*) Gear P rotates at 100 rpm clockwise and gear Q is stationary. 10



(*b*) Explain the functioning of a centrifugal governor, using a diagram. Also explain the terms : sensitiveness & hunting of a governor. 10

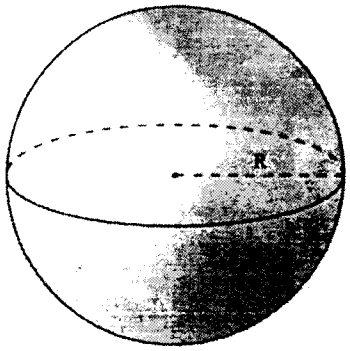
4. (*a*) In a single degree damped vibrating system 10 kg mass is suspended which makes 25 oscillations over a period of 20 seconds. It is observed that amplitude decreases to 1/4 of the initial value after five oscillations. Determine the stiffness of the spring, logarithmic decrement and damping factor. 10

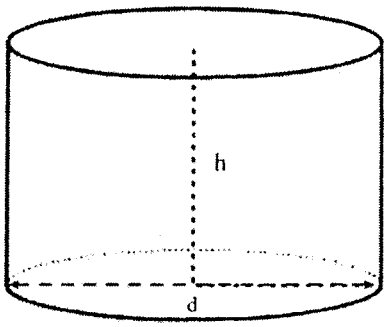
(*b*) Using a diagram describe spiral, cylindrical, conjugate and spherical cams. 10

5. (*a*) Draw an iron-iron carbide phase diagram. With reference to this, explain the presence of phases like ferrite, austenite and cementite. Also discuss the properties of these phases. 10

(*b*) Why is case hardening desirable ? Explain case hardening processes like carburizing, cyaniding and nitriding. 10

6. (*a*) Two work pieces with same volume have to be sand casted. As shown below, one of the castings is spherical and other is cylindrical. Which casting will solidify faster ? Justify. 10





h = d

(b) Suggest a welding process which is most suitable under the following conditions and explain its working :

(i) A railway track has developed a major crack in a remote area and needs to be repaired.

(ii) A thick plate needs to be welded for a pressure vessel. 2×5

7. (a) Is USM a non-conventional machining process ? Justify. Explain the principle and working mechanism of 'USM' process, using a neat sketch. Also describe the applications, advantages and limitations of this non-conventional machining process. 10

(b) The following data pertains to sale of gas stoves for a company X in North India over previous three years. Using 'Times Series Analysis' method; make a quarterly sales forecast for the year 2023 for the company. 10

Year	**Quarter**	**Sales (in thousand units)**
2020	1	71.2
	2	65.8
	3	54.8
	4	82.8
2021	1	77.9
	2	70.5
	3	62.2
	4	88.9
2022	1	85.0
	2	70.5
	3	68.5
	4	92.6

8. (*a*) How are quality control charts classified ? Explain the difference between 'defects' and 'defectives'. A car showroom has fifteen cars and each car has some defects, as shown in the table below. Draw a suitable quality control chart for the given data : 10

Car Number	Number of Defects
1	12
2	9
3	8
4	10
5	7
6	11
7	8
8	9
9	10
10	10
11	6
12	4
13	7
14	8
15	11

(*b*) Describe the following : 4×2.5

(*i*) Brazing and Soldering

(*ii*) Tool Geometry

(*iii*) Cold Extrusion

(*iv*) PERT versus CPM.