

**NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR****Even Semester Mid-term Examination, 2022-23****Course Code:** MEC 401

Full Marks: 25

**Course Name:** Design of Machine Element

Time: 90 Minutes

Question Paper No.: NITDGP/MEC401/1

Date of Exam: 20/02/2023

Instructions: Answer all the questions.

Ques No.	Question	Marks	Mapped CO
1	What do you understand from the term factor of safety in machine design. Explain with a suitable example.	2	CO1
2	The stresses induced at a critical point in a machine element made of 45C8 are given below. $\sigma_x = 120 \text{ MPa}$ ; $\sigma_y = 40 \text{ MPa}$ ; $\tau_{xy} = 80 \text{ MPa}$ ; $\sigma_z = \tau_{zx} = \tau_{yz} = 0$ ; Calculate the factor of safety. Also give your comment on your computed result. Assume that the yield strength of steel 45C8 material is 380 MPa.	5½	CO2
3	Derive an analytical expression for the computation of the diameters of a hollow shaft subjected to a transverse bending moment $M$ , an axial torque $T$ and an axial force $F$ , using maximum shear stress theory of failure. Use the following symbols. $[\tau]$ = Allowable shear stress; $d_o$ = Outer diameter of the hollow shaft; $d_i$ = Inner diameter of the hollow shaft; $k = d_i / d_o$ ; $K_m$ = Combined shock and fatigue factor of bending moment; $K_t$ = Combined shock and fatigue factor of axial torsion; $\alpha$ = Column- action factor.	5	CO2
4	(a) What is the scope of ergonomics? Why is it important in machine design? (b) Briefly explain how design synthesis differs from design analysis. (c) Why are standards required in design? How do they differ from codes? (d) What are the important advantages of cast iron from design considerations? How will you designate plain carbon steel with average 0.6% Carbon and average 0.4% manganese.	1½+1+1+1½= 5	CO1
5	A railway engine has to be provided with two buffers containing identical closely coiled helical compression springs in parallel arrangement. The engine which weights 2000 kg has a travel speed of 2 m/sec when it touches the buffers and comes to rest. The springs are compressed by 200 mm in bringing the wagon to rest. The springs are made of oil- tempered and hardened steel wire with ultimate tensile strength of 1250 MPa and modulus of rigidity of 81370 MPa. Assuming factor of safety is 2 and a spring index of 6, calculate the following: (i) wire diameter, (ii) number of active coils in each spring.	3	CO2
6		P.T.O	

**Course Outcomes**

CO1 Acquire an idea about engineering materials in machine design

CO2 To learn the basic design procedure for different elementary machine elements

CO3 To learn about design of bolt and welded joints, pressure vessels etc.



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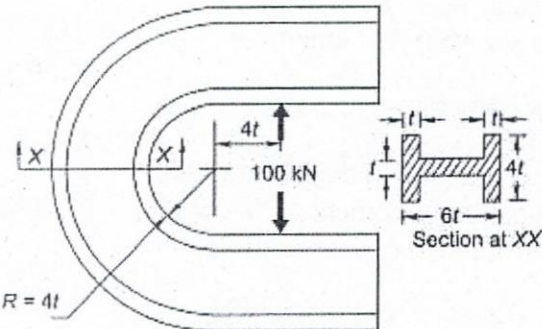
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Ques No.	Question	Marks	Mapped CO
6	<p>A C-frame of a press is subjected to a force of 100 kN is shown in Fig. A. It is made of grey cast iron FG 300 (Min. tensile strength=300 MPa) and factor of safety is 3. Determine the “t” of the cross-section at XX.</p>  <p align="center"><b>Fig. A</b></p>	4½	CO2

Course Outcomes

CO1 Acquire an idea about engineering materials in machine design

CO2 To learn the basic design procedure for different elementary machine elements

CO3 To learn about design of bolt and welded joints, pressure vessels etc.

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2022-23

**CASTING, FORMING AND WELDING****MEC - 402**

Full Marks : 25

Time : Ninety Minutes

*The figures in the margin indicate full marks.**Answer all the questions.*

Make a neat and well labelled diagram wherever necessary.

1. Explain the advantages of casting process over other manufacturing processes. 3 [CO1]
2. List out different components generally manufactured by casting. 2 [CO2]
3. Label different parts of a mould assembly in a neat sketch of a mould just before pouring molten metal. 3 [CO2]
4. Take two solid cylindrical specimens of equal diameter but different heights and compress them (frictionless) to the same percentage reduction in height. Find the ratio of final diameters of both cylinders. 5 [CO4]
5. Explain strain hardening and how strain hardening is beneficial in case of cold working process? 3 [CO4]
6. How does a Constant Voltage power source ensures self-regulation of the arc?

P.T.O.



( 2 )

Name two welding processes where Constant Voltage power source is used. 3+1 [CO3]

7. Draw a neat diagram of a Gas Welding Torch and label ALL its parts. *No need of explanation only the labelled diagram is needed.* 5 [CO3]
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Course Outcomes :

- CO1 : Learn different types of casting process.
- CO2 : Select suitable manufacturing process for typical components.
- CO3 : Learn the various welding process.
- CO4 : Explain the concept of forging, rolling process and drawing.

2022-23

**HEAT AND MASS TRANSFER**

**MEC - 403**

Full Marks : 25

Time : Ninety Minutes

*The figures in the margin indicate full marks.*

*Answer all the questions.*

Graph paper shall be supplied, if required.

1. Qualitatively write a mathematical expression applicable to a control volume for the generalized conservation principle typical for a macroscopic unsteady phenomenon. Fit the first and second law of thermodynamics into this framework. Then eliminating the floating quantity heat from the expression from the first law of thermodynamics and the "so called conservation." form of second law of thermodynamics labelled in the form of entropy generation rate arrive at the result that the lost available power is directly proportional to the rate of entropy generation. 9 [CO1]
2. (a) Derive two dimensional time-dependent heat conduction equation with constant internal heat generation and variable thermal conductivity in Cartesian coordinate system.  
  
(b) An exterior wall of a house consists of a 10.16 cm layer

P.T.O.

( 2 )

of common brick having thermal conductivity of  $0.7 \text{ W/m.K}$ . It is followed by a  $3.8 \text{ cm}$  gypsum plaster with thermal conductivity of  $0.48 \text{ W/m.K}$ . What thickness of loosely packed rockwool insulation ( $k=0.065 \text{ W/m.K}$ ) should be added to reduce the heat loss through the wall by 80%? 3+5 [CO2]

3. (a) Write the definition of spectral intensity. Write the major characteristics of a black body. Write mathematical expressions for the spectral intensity and emissive power of a black body. Illustrate Wien's displacement law graphically.
- (b) The wavelength and speed of radiation travelling within a medium are  $3.2 \text{ micron}$  and  $2.3 \times 10^8 \text{ m/s}$ , respectively. Determine the wavelength of the radiation in vacuum.
- (c) What is the fraction of the total hemispherical emissive power leaving a diffuse emitter in the direction  $20^\circ \leq \theta \leq 50^\circ$  and  $10^\circ \leq \phi \leq 70^\circ$ . 5+1+2 [CO4]

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Course Outcomes :

- CO1 : Relation between thermodynamics and heat transfer.
- CO2 : Knowledge of conduction mode of heat transfer.
- CO3 : Knowledge of convection mode of heat transfer.
- CO4 : Knowledge of radiation mode of heat transfer.
- CO5 : Heat and mass transfer equipments.



**NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR****Even Semester Mid-term Examination, 2022-23****Course Code:** MEC432

Full Marks: 25

**Course Name:** Mechanical design of equipment & components

Time: 90 Mins

Question Paper No.: NITDGP/MEC432/x

Date of Exam: 23/02/2023

Instructions: **Answer all the questions.** (Assume suitable data, if required. Symbols, used in questions, bear usual meaning. Answer in short and to the point in your own language. Your solution must contain appropriate assumptions, intermediate steps and necessary reflections.)

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	<p>(a) Indicate the difference between heat and work with an illustrative example?</p> <p>(b) Air at a pressure of <math>P_i</math> and a temperature of <math>T_i</math> is flowing in a pipe. Connected to this pipe through a valve is an evacuated tank. The valve is opened and the tank fills with air until the pressure is <math>P_i</math>, and then the valve is closed. The process takes place adiabatically, and the changes in kinetic and potential energies are negligible. Determine the final temperature of the air.</p>	2+4 =6	CO1
2	<p>(a) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure, and 0.95 m<sup>3</sup>/kg volume, and leaving at 5 m/s velocity, 700 kPa pressure, and 0.19 m<sup>3</sup>/kg volume. The internal energy of the air leaving is 90 KJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 KW. Compute the rate of shaft work input to the air in KW. Find the ratio of the inlet pipe diameter to the outlet pipe diameter.</p> <p>(b) Provide the thermodynamic definition of heat.</p>	4.5+2 =6.5	CO2
3	<p>(a) What do you understand from the following terminologies? i) Margin of safety; ii) Factor of safety; Explain with suitable examples.</p> <p>(b) Develop an analytical relation between margin of safety and factor of safety.</p>	3.5 + 3 = 6.5	CO4
4	<p>(a) The principal stresses induced at a critical point in a machine element made of steel 50C4 are given below <math>\sigma_1 = 200</math> MPa <math>\sigma_2 = 150</math> MPa and <math>\sigma_3 = 0</math> Calculate the value of factor of safety, using Maximum shear stress theory of failure. Also give your comment on your computed result of factor of safety. Assume that the yield strength of steel 50C4 material is 460 MPa.</p> <p>(b) Write a short note on Maximum principal stress theory of failure.</p>	3 + 3 = 6	CO4

**Course Outcomes**

- CO1: System to control volume formulation.  
 CO2: Mathematical formulation of laws of thermodynamics.  
 CO3: Properties of pure substances.  
 CO4: Knowledge of stress and strain.  
 CO5: Principles of machine design.



Q. No. MEC 602/ 183

B.TECH/EVEN  
REG/(22-23)

Even Semester Mid-term Examination, 2022-23

**INDUSTRIAL ENGINEERING AND  
MEASUREMENT**

**MEC 602**

*Full Marks : 25*

*Time : 90 Minutes*

*The figures in the margin indicate full marks.*

*Make a neat and well labeled diagram  
wherever necessary.*

*Answer all the questions.*

Question No.	Body of the Question	Marks	Mapped CO
1.	What are the three Classical theories of Management and the name of the person who proposed them?	3	CO1
2.	What are the 4 types of organization based on duration and complexity of objective? Give one example for each.	4	CO1
3.	Explain any 3 controllable and 3 uncontrollable factors for selecting a plant location.	6	CO1
4.	With neat Blok Diagram describe a Generalized Measurement System. Describe in brief the functions of each stage.	2	CO5
5.	Define "Static Calibration" and "Static Sensitivity"?	2	CO5
6.	A Hg-glass Thermometer has a capillary of 0.2 mm bore diameter. What volume of Hg the bulb should contain		



to have a sensitivity of 3mm/ °C. Operating temp is 20 °C, the volume expansion coefficient of Hg is 0.00017/ °C. Neglect the expansion of glass. 3 CO5

7. What is true value of a measurand? Define the term 'static error' and 'relative error'. 2+1 CO5
8. An inclined limb manometer used for measurement of flow rate, reads  $0.201 \times 10^{-3} \text{ m}^3/\text{s}$ . True value of flow rate is  $0.199 \times 10^{-3} \text{ m}^3/\text{s}$ . Determine the static error and static correction. 2 CO5

### COURSE OUTCOMES

- CO1: Knowledge on the structures of Engineering Organization in general.
  - CO2: Planning of manning and production line.
  - CO3: Ability for material management.
  - CO4: Indian standards of measurement.
  - CO5: Techniques of engineering measurements with its application.
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