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. $\sigma_x = 120$ MPa; $\sigma_y = 40$ MPa; $\tau_{xy} = 80$ 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 shack and fatigue factor of bending moment; K_t = Combined shack and fatigue factor of axial torsion; α = 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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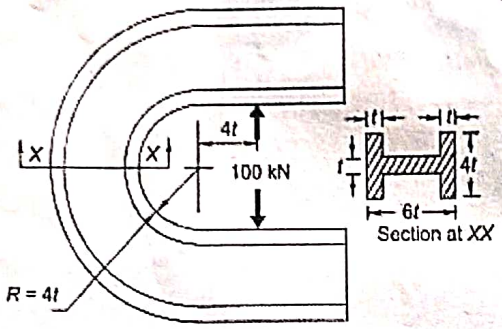
6	A C-frame of a press is subjected to a force of 100 kN is shown in Fig. A. It is made of grey cast iron FG 300 (Min. tensile strength=300 MPa) and factor of safety is 3. Determine the "t" of the cross-section at XX.  Fig. A	4½	CO2

Course Outcomes
CO1 Acquire an idea about engineering materials in machine design
CO2 To learn the basic design procedure for different elementary machine elements
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Q. No. MEC - 402 037 ND/B.Tech./Even

Reg/2022-23

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.

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 lable ALL its parts. *No need of explanation only the labelled diagram is needed.* 5 [CO3]

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.

Q. No. MEC - 403 37 ND/B.Tech./Even

Reg/2022-23

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.

of common brick having thermal conductivity of 0.7W/m.K. It is followed by a 3.8 cm gypsum plaster with thermal conductivity of 0.48 W/m.K. What thickness of loosely packed rockwool insulation (k=0.065W/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. Illstrate Wien's displacement law graphically.

(b) The wavelength and speed of radiation travelling within a medium are 3.2 micron and 2.3×10^8 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 $20°\leq\theta\leq50°$ and $10°\leq\phi\leq70°$. 5+1+2 [CO4]

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.

Q. No. EEC - 432 11 ND/B.Tech./Even

Reg/2022-23

2022-23

ELECTRICAL MACHINES

EEC - 432

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Answer any *five* questions.

1. Draw and explain the different parts of dc machines. Also derive the e.m.f. equation of dc generator.

3+2 [CO1 & CO2]

2. Explain the process of voltage build-up of dc shunt generator. Mention the condition and importance of voltage build up.

2.5+2.5 [CO1 & CO3]

3. Draw and illustrate all the characteristics of dc shunt motor.

5 [CO1 & CO3]

4. A load of 7.5 kW at 230V is supplied by a short-shunt cumulatively compound DC generator. If the armature, series, and shunt field resistances are 0.4, 0.3 and 100 ohms respectively. Calculate the induced emf and the load resistance.

5. A dc shunt motor rated 10 kW connected to 250V supply is loaded a draw 35A armature current running at a speed

P.T.O.

of 1250 rpm. Given Ra = 0.5 ohm, (a) Determine the load torque if the rotational loss is 500W. (b) Determine the motor efficiency if the shunt field resistance is 250 ohms. 5 [CO5]

6. A dc shunt motor runs at 1200 rpm on no-load drawing 5 A from 220V mains. Its armature and field resistances are 0.25 ohm and 110 ohms respectively. When loaded, the motor draws 62A from the mains. What would be its speed? Assume that the armature reaction demagnetizes the field to the extent of 5%. Also calculate the internal torque developed at no-load and on load. What is the motor shaft troque at load. 5 [CO5]

Course Outcomes :

- CO1 : Theory of electromechanical energy conversion, the concepts of voltage generation and fundamental torque equation.
- CO2 : Basic understanding of the principles of operation and construction of direct and alternating current machines and transformers.
- CO3 : A study of theory and concept of Electric Machines (AC & DC)
- CO4 : Deriving equivalent circuit of electrical machines.
- CO5 : Studying the performance and characteristics of Electrical machines (AC & DC)