Ex/ME/T/225/2019

B.E. MECHANICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2019

Subject: MACHINE DESIGN I **Time: Three Hours** **Full Marks: 100**

Missing data, if any, are to be reasonably chosen.
Give sketches wherever applicable.
Answer any **Four (04)** questions

1. a) Compare rational design and optimum design. b) Discuss in detail the considerations of manufacturing aspects in design. c) Discuss the fundamental design considerations. d) Discuss the points to be considered for selection of material. e) Discuss the toughness property of material and its measurement. *(06+05+05+04+05)*

2. a) Design a cotter joint based on rational design. b) How the material properties can be improved? c) Categorize cast irons. d) How do the mechanical properties vary with temperature and percentage of carbon? *(12+05+04+04)*

3. a) Discuss the significance of failure theory in design. b) Compare von-Mises and Tresca failure theories. c) Explain one failure theory for brittle material with unequal strength in tension and compression. d) Discuss the factors influencing factor of safety. e) An element is loaded by stresses σ_x= 119 MPa, σ_y= 7 MPa, and τ_{xy}= 42 MPa. Material is cast iron with σ_{ut}= 200 MPa and σ_{uc}= 730 MPa. Will the part fail if the factor of safety is 1.5. *(03+06+04+04+08)*

4. a) Explain the significance of fracture mechanics in design. b) What is G and prove that it is equal in load controlled and displacement controlled conditions. c) What is stress intensity factor? d) How fracture toughness depends on the thickness of the specimen? e) Explain the condition for stable and unstable crack growth. f) Calculate the factor of safety based on the following data: maximum allowable crack length = 1.2 mm, σ_{yp} =550 N/mm^2, K_{IC}= 10 MPa$\sqrt{m}$ and loaded to a stress of 310 MPa. *(03+05+03+05+04+05)*

5. a) Explain S-N curve and its applications in design for non-zero mean stress. b) Derive the strain life equation applicable to low cycle and high cycle fatigue both. c) A machine part is operated for a time of 4.8 hours at σ_1 stress level. The load is removed and the part is operated at a stress level of σ_2 for a time of 7.2 hours when the failure occurs. If the life of the component at σ_2 stress level alone is 7.5 hours, calculate the life of the component at σ_1 stress level alone. Frequencies of applied periodic loads remain same for both the cases. d) A solid circular steel shaft, 15 mm in diameter, is subjected to torsional shear stress which varies from 0 to 35 MPa and at the same time, is subjected to an axial stress that varies from 30 N/mm^2 to 80 N/mm^2. The frequencies of variations of these stresses are equal to the shaft speed. Calculate the factor of safety considering the following: σ_{ut}= 540 MPa, σ_{yt}= 400 MPa and σ_e= 200 MPa.
(07+06+04+08)

6. a) Discuss the design principles of column considering stability. b) Discuss the influences of stress concentration in design. c) Explain the creep curve and its significance. d) What is stress rupture test? e) How creep test data is presented? f) Discuss Andrade's and Garofalo's equations. *(06+04+04+03+04+04)*

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