Code No: RR422102 **Set No. 1**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
FATIGUE AND FRACTURE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Make a schematic sketch of the fatigue behavior for some metals for which the stress ratio has a value of +1.
   (b) The mean stress during a fatigue test was 100 MPa and the stress range was 500 MPa. Compute: [1 6]
      i. Maximum stress
      ii. Minimum stress
      iii. tress ratio.
2. (a) Describe typical Notch bar impact test to determine the impact strength.
   (b) Explain the effect of stress concentration and size of specimen on fatigue properties. [16]
3. (a) Explain the different types of fatigue cycles.
   (b) With the help of diagrams, explain the various types of fluctuating stresses which can cause fatigue. [16]
4. (a) Explain the theory of Miners law.
   (b) Express Miners law in mathematical terms.
   (c) In a smooth bar rotating beam fatigue test, underfully reversed loading it is found that failure of a mild steel occurs on loading (at 1/4 cycle) at a stress of 420 MPa. At a stress amplitude of 210 MPa the number of cycles to failure is 10^6. How long a part will last at a stress amplitude of 280MPa if it is first subjected to a stress amplitude of 315 MPa for 1000 cycles. [16]
5. (a) Explain stage I and stage II fatigue crack growth with suitable sketches.
   (b) What are the potential sites for fatigue crack initiation in a material? Explain them. [16]
6. (a) Explain about the griffiths crack theory of fracture
   (b) Derive an expression for the theoretical brittle fracture strength. [16]
7. (a) How does improved, alloy cleanliness develop the fracture toughness of the parts?
   (b) How does the micro-structure of the materials optimize the fracture toughness? [16]

8. Identify and explain several problems a designer must recognize when dealing with fatigue loading as compared with static loading. [16]

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Code No: RR422102 **Set No. 2**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
FATIGUE AND FRACTURE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Write soderberg equation and state its application to different type of loadings.
   (b) What information do you obtain from soderberg diagram. [16]

2. (a) Distinguish clearly between Notch toughness, notch brittleness and notch sensitivity.
   (b) What is notch sensitivity index.
   (c) Discuss the effect of [16]
      i. Surface condition &
      ii. stress concentration on fatigue.

3. (a) Explain why fatigue strength is a statistical quantity.
   (b) Based on dislocation theory, explain how dislocations are multiplied and strain hardening occurs. [16]

4. (a) Explain the theory of Miners law.
   (b) Express Miners law in mathematical terms.
   (c) In a smooth bar rotating beam fatigue test, underfully reversed loading it is found that failure of a mild steel occurs on loading (at 1/4 cycle) at a stress of 420 MPa. At a stress amplitude of 210 MPa the number of cycles to failure is 10^6. How long a part will last at a stress amplitude of 280MPa if it is first subjected to a stress amplitude of 315 MPa for 1000 cycles. [16]

5. Give the 3 expressions for crack propagation rate in terms of the following and explain them.
   (a) Crack length.
   (b) Total strain.
   (c) Stress intensity factor. [16]

6. (a) Why is a surface of a solid associated with surface energy (or free energy)? What is an approximate value of the free energy of surface of a metal
   (b) Actual energy required in a ductile material to create two new surfaces through the crack growth is several orders higher than the surface energy of solids. Why so? [16]

7. (a) An Aluminum alloy after a certain heat treatment exhibits a fracture toughness of 23.5 Mpa $\sqrt{m}$. What is the largest flaw size the material can with stand during service condition in which the maximum stress is 280 Mpa

   (b) Explain the effect of the thickness of a specimen on fracture toughness. [16]

8. Discuss in detail the historical remarks about fatigue failure with suitable examples. [16]

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Code No: RR422102 **Set No. 3**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
FATIGUE AND FRACTURE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A fatigue test was conducted in which the mean stress was 50 MPa (7250PSI) and the stress amplitude was 225 MPa (32,625 PSI).
   i. Compute the Maximum and Minimum stress levels
   ii. Compute the stress ratio
   iii. Compute the Magnitude of stress range.
   (b) What is mean stress? What are the various methods available to determine S-N diagram for a material where mean stress is not zero? Explain any two methods of presenting the data. [16]

2. (a) Distinguish clearly between Notch toughness, notch brittleness and notch sensitivity.
   (b) What is notch sensitivity index.
   (c) Discuss the effect of [16]
   i. Surface condition &
   ii. stress concentration on fatigue.

3. (a) Explain typical fatigue stress cycles with the help neat sketches.
   (b) Represent fatigue data on a probability basis and explain it. [16]

4. (a) Explain the theory of Miners law.
   (b) Express Miners law in mathematical terms.
   (c) In a smooth bar rotating beam fatigue test, underfully reversed loading it is found that failure of a mild steel occurs on loading (at 1/4 cycle) at a stress of 420 MPa. At a stress amplitude of 210 MPa the number of cycles to failure is 10^6. How long a part will last at a stress amplitude of 280MPa if it is first subjected to a stress amplitude of 315 MPa for 1000 cycles. [16]

5. (a) Explain strain hardening.
   (b) With the help of sketch, explain the formation of sessile dislocations that result in strain hardening of FCC metals. [16]

6. (a) Sketch typical fatigue fracture surface and explain.
   (b) Explain some of the methods of protection of materials from surface crack propagation. [16]

7. (a) An Aluminum alloy after a certain heat treatment exhibits a fracture toughness of 23.5 Mpa $\sqrt{m}$. What is the largest flaw size the material can with stand during service condition in which the maximum stress is 280 Mpa

   (b) Explain the effect of the thickness of a specimen on fracture toughness. [16]

8. Identify and explain several problems a designer must recognize when dealing with fatigue loading as compared with static loading. [16]

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Code No: RR422102 **Set No. 4**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
FATIGUE AND FRACTURE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss the procedure for determining an S-N curve and draw the S-N curve for steel explaining its importance.
   (b) Discuss a typical fatigue testing procedure. Explain how the effect of mean stress can be studied. [16]

2. (a) In case of negative stress ratio, σ_{min} is taken to be zero why so?
   (b) Explain the following terms: [16]
      i. plastic strain concentration factor
      ii. Plastic stress concentration factor.

3. (a) Explain why fatigue strength is a statistical quantity.
   (b) Based on dislocation theory, explain how dislocations are multiplied and strain hardening occurs. [16]

4. (a) Explain the theory of Miners law.
   (b) Express Miners law in mathematical terms.
   (c) In a smooth bar rotating beam fatigue test, underfully reversed loading it is found that failure of a mild steel occurs on loading (at 1/4 cycle) at a stress of 420 MPa. At a stress amplitude of 210 MPa the number of cycles to failure is 10^6. How long a part will last at a stress amplitude of 280MPa if it is first subjected to a stress amplitude of 315 MPa for 1000 cycles. [16]

5. (a) Discuss the effects of surface condition, stress concentration, and metallurgical factors on fatigue.
   (b) Explain the successive stages in the operation of a Frank-Reed source for multiplication of dislocations. [16]

6. (a) Explain about the griffiths crack theory of fracture
   (b) Derive an expression for the theoretical brittle fracture strength. [16]

7. (a) An Aluminum alloy after a certain heat treatment exhibits a fracture toughness of 23.5 Mpa $\sqrt{m}$. What is the largest flaw size the material can with stand during service condition in which the maximum stress is 280 Mpa
   (b) Explain the effect of the thickness of a specimen on fracture toughness. [16]

8. (a) In a short fibre composite material an embedded fibre does not act like a dangerous crack. Explain it by assuming the fibre has a shape of an ellipse.

(b) List some of the factors you would consider in designing a crank shaft for an automobile engine. What would you suggest as steps to improve fatigue life of the crank shaft. [16]

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