Winter 2020
MSE160
Multiple Choice Final Assessment
Due: April 22^{nd} 2020 by 11:59 pm

VERSION 153

NOTE: THIS IS A FINAL ASSESSMENT, THEREFORE LATE SUBMISSIONS WILL NOT BE ACCEPTED

This means that if you do not submit your responses successfully by the deadline you will not be able to submit and you will need to submit an official petition. Therefore, it is highly advisable that you make plans to complete and submit your final responses at least 2-3 hours early.

Instructions:

- You must correctly indicate your test version code on your the Microsoft form. If you do not, or fill this in incorrectly, your final assessment will not be graded.
- Answer all questions.
- Fill in the answers on the Microsoft Form.

1. When completing a Burgers circuit at different points along a mixed dislocation, it is important to always do which of the following?

   (a) Always begin at a point on the dislocation line
   (b) Always view the dislocation line in the same direction
   (c) Always construct the Burgers circuit along a plane parallel to the dislocation line
   (d) Always encircle the dislocation in a clockwise manner, when viewed from the outside of the crystal

2. It is possible for a metallic component to fail under cyclic loading conditions when only loaded within the linear elastic region?

   (a) True
   (b) False

3. A stress is applied along the [011] direction. Along which of the following slip systems would would dislocations NOT move as a result of this stress?

   (a) $[\bar{1}11](110)$
   (b) $[111](\bar{1}10)$
   (c) $[\bar{1}\bar{1}1](011)$
   (d) $[111](\bar{1}01)$

4. Two specimens of the same precipitation hardenable aluminum alloy are produced. The solidus of this alloy is 582°C. Both samples are solution heat treated. Sample A is then plastically deformed by 30% followed by an artificial aging heat treatment of 6 hours at 155°C. Sample B is artificially aged for 6 hours at 155°C and then plastically deformed by 30%. Which of the following is most likely to be true?

   (a) Sample A and sample B will have roughly the same strength and approximately the same amount of energy will have been used in the processing of both samples
   (b) Sample A will have a higher strength than sample B and approximately the same amount of energy will have been used in the processing of both samples.
   (c) Sample A will have a higher strength than sample B but more energy will have been used in the processing of sample A
   (d) Sample A and sample B will have roughly the same strength but more energy will have been used in the processing of sample B.

5. A hypothetical fan blade from a turbofan engine is produced from Ti6Al4V. The yield strength, tensile strength, and fracture toughness of this alloy are 790 MPa, 860 MPa, and 100 MPa $m^{-1/2}$, respectively. It is known that one of these fan blades will fracture by rapid crack propagation when the maximum surface crack length is 5.5 mm. Approximating the geometric factor as 1, estimate what the stress in the fan blade was when fracture occurred.

   (a) 429 MPa
   (b) 1.0 GPa
   (c) 760 MPa
   (d) 538 MPa

6. Which of the following is not a possible slip system for BCC?

   (a) $[\bar{1}11](011)$
   (b) $[111](011)$
   (c) $[111](1\bar{1}0)$
   (d) $[1\bar{1}1](121)$

7. Given the work hardening coefficient K and exponent n for each of the following alloys, which would you expect to have the highest ductility?

   (a) Annealed 70-30 brass (K=875 MPa, n = 0.50)
   (b) Annealed copper (K = 310 MPa, n = 0.55)
   (c) AA6061-T6 aluminum (K = 415 MPa, n = 0.04)
   (d) Annealed low carbon steel (K = 540 MPA, n = 0.25)

8. Astrid and Brodie are both preparing concrete beams for a concrete beam contest. The dimensions of the beams are 22 cm $\times$ 22 cm $\times$ 74 cm. They both decide on the same relative amounts of water, concrete, sand, and coarser aggregate (stones). The only difference between their concrete blends is that Astrid decides to use clean crushed stones, while Brodie uses clean river rock for the stones. Which of the following is the most likely outcome of the contest?

   (a) Astrid's concrete is stronger than Brodie's and has a higher fraction of intergranular fracture
   (b) Astrid's concrete is stronger than Brodie's and has a higher fraction of transgranular fracture
   (c) Brodie's concrete is stronger than Astrid's and has a higher fraction of transgranular fracture
   (d) Brodie's concrete is stronger than Astrid's and has a higher fraction of intergranular fracture

9. The plane strain fracture toughness K_{IC} is appropriately applied under which of the following conditions?

   (a) Relatively thick components loaded in a shear loading configuration
   (b) Relatively thick components loaded in a crack opening configuration
   (c) Relatively thin components loaded in a crack opening configuration
   (d) Relatively thin components loaded in a shear loading configuration

10. Which of the following statements about impurities in a crystalline metal is correct?

    (a) Substitutional impurities that are smaller than the solvent atoms tend to remain homogeneously distributed throughout the lattice, while substitutional impurities that are larger than the solvent atoms tend to concentrate in the lattice just above a positive edge dislocation.
    (b) Substitutional impurities that are larger than the solvent atoms tend to concentrate in the lattice just above a positive edge dislocation.
    (c) Substitutional impurities that are larger than the solvent atoms tend to concentrate in the lattice just below a positive edge dislocation.
    (d) Substitutional impurities that are larger than the solvent atoms tend to remain homogeneously distributed throughout the lattice, while substitutional impurities that are smaller than the solvent atoms tend to concentrate in the lattice just below a positive edge dislocation.

11. Akari is using a gas lawn mower to cut the grass outside her home. Her young son Sergey is very curious and has left two small pebbles in the lawn, one in front of the living room window and one in front of the family car. When Akari passes over each pebble, the lawn mower propels the pebble into the living room window and then the side window of the car, respectively. Assuming the pebbles hit each glass surface with the same energy and that the glass panels are the same thickness, which is the most probable of the following possible outcomes of these events?

    (a) The living room window will break, while the car window will plastically deform and Sergey will receive a stern talking-to.
    (b) The living room window will break into a few large pieces, while the car window will break into many small pieces, and Sergey will be receive a stern talking-to.
    (c) The living room window will break into many small pieces, while the car window will break into a few large pieces, and Sergey will be receive a stern talking-to.
    (d) The living room window will not break, while the car window will break and Sergey will be receive a stern talking-to.

12. A 35 MPa stress is applied to a FCC crystal along the [110] direction. Determine the resolved shear stress on the $[011](11\bar{1})$ slip system.

    (a) 14.3 MPa
    (b) 12.4 MPa
    (c) 20.2 MPa
    (d) 23.3 MPa

13. Orthopedic joint replacements are frequently made from titanium and commonly these implants are secured to the bone via a porous coating into which bone grows to form. Engineers must be careful not to place these porous coatings along which regions of these implants, and for which reason?

    (a) Compressive surfaces because these porous coatings act as stress concentrations that will cause necking in the implants
    (b) Compressive surfaces because these porous coatings act as crack initiation sites, significantly reducing the fatigue life of the implant
    (c) Tensile surfaces because these porous coatings act as stress concentrations that will cause necking in the implants
    (d) Tensile surfaces because these porous coatings act as crack initiation sites, significantly reducing the fatigue life of the implant

14. You are designing a pencil box and must decide between using a living hinge (a hinge in which the material itself bends to form the hinge) and a traditional mechanical hinge (similar to what you would find on a door). The materials that you have access to are polyethylene with a fatigue endurance limit of roughly 40 MPa and a yield strength of 110 MPa, and steel with a fatigue endurance limit of 340 MPa and a yield strength of 455 MPa. Assuming you can design the living hinge with polyethylene such that the service load is 32 MPa and considering only the service lifetime of the hinge, which of the following designs should you use?

    (a) Steel mechanical hinge
    (b) Polyethylene living hinge
    (c) Unable to determine
    (d) Polyethylene mechanical hinge

15. The Burgers vector is perpendicular to which of the following in a moving edge dislocation?

    (a) The direction of movement of the dislocation line
    (b) The applied shear stress causing slip
    (c) The slip plane
    (d) The dislocation line

16. A microscope image of an unknown material specimen reveals an equiaxed grain structure. Which of the following is NOT a possible history for this specimen?

    (a) Cast, cold-rolled and recrystallized
    (b) As-cast
    (c) Cast and then cold-rolled
    (d) Cast and annealed

17. A hypothetical elevator component has a fracture toughness of $85\,\mathrm{MPa\,m^{-1/2}}$. The smallest internal crack that can be detected during regularly scheduled non-destructive testing is 2.8 mm. Determine the maximum safe service load for this component, assuming a safety factor of 11.

    (a) 14 GPa
    (b) 117 MPa
    (c) 1.3 GPa
    (d) 82 MPa

18. The fracture toughness is to the stress intensity, as the...?

    (a) Load is to the stress
    (b) Strength is to the stress
    (c) Stress is to the load
    (d) Stress is to the strength

19. A wooden component of an oak bench at an art gallery has, over the period of several years of use, developed a crack running along the grain of the wood. A carpenter decides to drill a small hole in the wood just in front of the crack tip. Which of the following is the most likely outcome?

    (a) The lifetime of the bench will be unaffected because the crack will simply continue to propagate across the other side of the hole.
    (b) The lifetime of the bench will be extended because the crack will be blunted by the hole and so the stress concentration factor will be reduced.
    (c) The lifetime of the bench will be decreased because the crack tip will be bigger when it enters the hole and so the stress concentration factor will be increased.
    (d) The lifetime of the bench will be decreased because the load bearing area of the component will be reduced and the stress will increase.

20. Which of the following thermo-mechanical treatments would be likely to result in a metal with the highest strength (of these options)?

    (a) Casting, heating just above the recrystallization temperature for y minutes, x% plastic deformation, heating just above the recrystallization temperature for y minutes.
    (b) Casting, x% plastic deformation, heating just above the recrystallization temperature for y minutes, heating just above the recrystallization temperature for y minutes, x% plastic deformation, x% plastic deformation.
    (c) Casting, x% plastic deformation, x% plastic deformation, heating just above the recrystallization temperature for y minutes, heating just above the recrystallization temperature for y minutes, x% plastic deformation.
    (d) Casting, x% plastic deformation, heating just above the recrystallization temperature for y minutes, x% plastic deformation, heating just above the recrystallization temperature for y minutes, x% plastic deformation.

Instructions:

- Congratulations, you've reached the end of the final assessment!
- Remember to submit your answers to Microsoft Forms.