SRINIVASAN ENGINEERING COLLEGE

AE2354 HIGH TEMPERATURE MATERIALS

16 MARKS

UNIT-1 <u>CREEP</u>

1. Explain in detail about the factors influencing functional life of components at elevated temperatures.

2. List out the metallurgical factors influencing various stages of creep using a suitable diagram, explain these stages.

3. What are the structural changes involved during creep? Explain in detail.

4. Briefly explain the three steps of creep with a creep curve.

5. Discuss the mechanism of creep deformation briefly with necessary sketches.
6. It is well known that at high tempe rature materials are subjected to creep corrosion and micro structural changes. Analyse each of the things in limiting functional life on components.

7. Write technical notes on various creep mechanisms.

8. It is well known that the functional life time of material put into service at high temperature are subjected to three dimensional damages by way of creep, corrosion and micro structural changes. For each type write on the various damage mechanisms and the method to combat them.

9. It is well known that to predict long term properties accelerated short term tests are to be carried out and extrapolating procedure by parametric approach is to be followed. Analyse how various parameters are evolved based on the material behaviour and how to choose the best parameters for Master curve.

10. Write the constitutive equations for plastic and creep deformations from high stress and low temperature to low stress and high temperature and comment on the mechanism of deformation for each equation.

UNIT-2
DESIGN FOR CREEP RESISTANCE

1. Analyse time hardening and strain hardening mathematically and pictorially and prove that for gradual loading strain hardening reduces strain hardening.

2. It is Obvious that as the material creeps it proceeds from primary stage into a steady state and accelerates into the tertiary stage with a end result of fracture.
   (i) For creep ductile failure or rupture the area of cross section that supports loadreduces to ze ro. Analyse how to compute time to rupture based on initial conditions.
   (ii) (ii) For creep brittle fracture void nucleate and grow form the onset of steady state and in tertiary state voids coalesce into cracks which propagates to produce fracture. This can be modelled by defining a damage parameter w which changes from zero at virgin state to unity at rupture .Based on this model compute time for brittle fracture.

3. Analyse hidden variables or internal variables on the primary and steady state creep deformation.

4. Derive expression for Creep ductile and creep brittle fractures .Also comment on the instantaneous fractures in both cases.

5. Analyse time hardening strain hardening pictorially and mathematically and prove that at constant stress the strain hardening reduces to time hardening.

6. Based on steady state creep rate derive expressions for creep ductile and brittle fracture.

7. (i) How will you obtain creep resistance through strain hardening?
   (ii)Explain stress rupture test at elevated temperature.

8. What are the approaches there for design under conditions of creep-fatigue interaction? Explain aii with neat sketches.

9. Derive the various methods adopted in representing rupture life of creep.

10. (i)Briefly explain the influence of brittle and ductile materials on creep.
    (ii) Discuss the conditions favourable for creep cavitation.

UNIT-3
FRACTURE

1. Derive an expression for cleavage I failure based on Orowan and Griffith Theory and comment how the various terms in these equations are responsible for strengthening and toughening the materials.

2. Derive an expression for cleavage II failure and ductile- brittle transition based on Micro void formation by plastic deformation and comment on the various metallurgical parameters affecting ductile-brittle transition.

3. Analyse technically the following fractures (4X4=16)
   - (i) Trans Granular Ductile fracture.
   - (ii) Inter granular creep fracture.
   - (iii) Pure diffusional Fracture.
   - (iv) Rupture.

4. Draw fracture maps for a bcc material or an oxide and explain various regimes.

5. What are the approaches there for design under conditions of creep-fatigue interaction? Explain all with neat sketches.

6. Discuss fractures at elevated temperature with fracture mechanism map.

7. Draw the fracture maps.
   - (i) For pure aluminium and commercially pure aluminium and explain the absence of intergranular creep failure field and large transgranular regime for pure aluminium.
   - (ii) For nickel, a nickel base super alloy and thoria dispe rsed nickel and explain the shrink and disappearance of some regimes.
   - (iii) For a bcc or a ceramic and mark all the regimes of fracture.

8. Briefly explain the theory of Ductile to Brittle transition with neat diagram.

9. Derive Orowon and Griffith theory of cleavage I failure.

10. What are the various types of fracture? Classify the fracture on the basis of type of loading extent of deformation and appearance

UNIT-4:
OXIDATION AND HOT CORROSION

1. Compare the parameters in controlling aqueous and dry corrosion. Discuss the kinetic laws of high temperature corrosion with special effect on the doping on the corrosion kinetics.

2. Analyse the hot corrosion mechanisms involved in basic and acidic fluxing.

   (i) Analyse how doping of a n-type and p-type semiconductor oxides influence corrosion kinetics.
   (ii) Analyse various kinetic laws of oxidation.

3. What are the kinematics principles in the Oxidation? Discuss in detail.

4. Describe the different metal-gas reactions and their remedies
   (i) It is well known that for corrosion resistance at high temperature there is a need for a formation of a adherent oxide scale to prevent the diffusion of deleterious species such as oxygen and sulphur through the scale and into the alloy. This is nearly impossible since the oxide scales are non-stoichiometric and defective such as n-type or a p-type oxide. Analyse how alloying or doping can influence the defect population and corrosion in defect structures.
   (ii) Analyse the various stages of hot corrosion with respect to exposure time various chemical equations and degradation mechanisms.

5. Fluxing in hot corrosion in loss of protective oxide due to dissolution. Analyse the various models for basic and acidic fluxing and effect of electrochemical polarisation on fluxing of various oxides with the help of phase stability diagrams

6. Explain the various stages of hot corrosion with mechanisms and super alloys.

7. Discuss the kinetic laws of oxidation and the fundamentals behind various method of combating corrosion.

UNIT-5:
SUPER ALLOYS AND OTHER MATERIALS

1. In developing a super alloy for high temperature application how alloy chemistry can be judiciously employed to produce resistance for creep, corrosion and micro structural instability.

2. It is also possible to produce resistance to the above three dimensional damage by different processing routes. Analyse please.

3. Write a technical note on the evolution of supe r alloys.

4. Analyse how the processing parameters can influence the mechanical properties of super alloys at high temperatures.

5. Briefly explain the major phases of nickel-base alloys

6. Explain strengthening of cobalt-base super alloys.

7. Draw fracture maps for pure Ni chrome a solid solution and a precipitation hardened nickel base super alloy and explain how the boundaries shifts due to alloying and precipitation.