Module 3 – Material Behaviour

Sample Questions

1. Explain how surface tension influences rising dampness in masonry walls.
2. Why is the spacing of atoms different on the surface of a liquid than within the liquid?
3. In a droplet of water, the surface is in tension and the water inside is in compression. True or false? Explain.
4. When is a solid surface fully wetted by a liquid?
5. How does the size of the pores in a solid affect the evaporation and freezing of water in them?
6. Explain the differences between chemisorption and physical adsorption.
7. How does adsorption affect creep in concrete?
8. What role does adsorption play in the swelling of clays?
9. What is the zeta potential?
10. What is meant by nonlinear elastic behaviour?
11. What are the parameters that are needed to describe the elastic response of isotropic material?
12. Polymers become more flexible when they are heated. Why?
13. What is the main difference between plastic and elastic deformations?
14. Which will have a higher yield strength: glass or aluminium?
15. There is no definite yield point in a polycrystalline material. Explain.
16. Explain the different stages of annealing?
17. Explain the S-N curve. What is the fatigue limit?
18. How is glass strengthened against tensile failure?
19. What can cause ductile-to-brittle transition in a metal?
20. Why do slip planes change directions when they cross grain boundaries?
21. Why is fatigue failure of concern?
22. For a certain amount of applied stress on titanium, wood and PVC, which of them would deform the most and which would deform least?
23. Though both are polymers, an epoxy would normally have higher stiffness than polyethylene. Why?
24. A crystal may have slip planes in different directions. Where will slip start during yielding?
25. Which will have more plastic deformation: zinc or aluminium? Why?
26. At which point in a polycrystalline material will slip first occur?
27. How do grain boundaries affect slip during yielding?
28. Give an example of a metal that fails in a brittle manner even at room temperature.
29. If a metal is cooled very much, would it tend to become more ductile or more brittle? Justify your answer.
30. How do the mechanical properties of a material generally change when it is heated?
31. How can ductility be defined?
32. How will a piece of wood fail due to slip under compression?
33. The strength of a thermoplastic polymer bar increases as it is being pulled. Why does this happen?
34. What is strain hardening?
35. How do the material properties change due to strain hardening?
36. What are the advantages and disadvantages of strain hardening or cold-working?

37. What happens in the microstructure of a metal that is undergoing strain hardening?
38. How does dislocation movement influence strain hardening?
39. What is annealing?
40. Can cold worked metal pieces be joined by welding? Why not?
41. Can mild steel fail in a brittle manner? Under what conditions?
42. Some metals can remain ductile even at low temperatures. What is that which makes this happen?
43. What is fundamental reason why there is a huge difference between the real and theoretical tensile strength of a brittle material?
44. What is fracture toughness?
45. Why is glass etched to strengthen it?
46. Why is tempered glass stronger than annealed glass?
47. How can design be done against fatigue failure? {Hint: Use the S-N curve.}
48. Why is fatigue failure probabilistic?
49. What is creep? What are the different stages of creep?
50. How is creep affected by the temperature of the material?
51. What are the different mechanisms that make creep occur in a metal body?
52. How is the strength of a material affected by creep mechanisms?
53. Will the tensile strength of a material change when the loading rate is increased? What can be expected to occur?
54. How can failure of a material such as steel be defined?
55. Why is the stress-strain behaviour of a metal required to determine the process of cold rolling it?
56. Describe strain-softening.
57. Draw schematic diagrams for idealised elastic-plastic and rigid-plastic responses.
58. What is the relation between the principal stresses and the maximum shear stress?
59. Can shear failure occur under hydrostatic compression?
60. In reality, the bulk modulus K can increase slightly at higher strains. Why?
61. The von Mises failure theory allows a higher principal stress than the yield strength under some conditions. What is the justification?
62. What is the limitation of the Tresca failure theory?
63. Under what conditions can a typically brittle material undergo plastic yielding?
64. How does fracture mechanics determine failure? How does this approach differ from conventional failure theories?
65. How does stress concentration influence failure?
66. According to linear elastic fracture mechanics, what is the magnitude of stress at a crack-like defect along the direction of the applied stress?
67. Which do you think will be most common mode of fracture in concrete? Why?
68. What is the stress intensity factor? What does it depend on?
69. What are the main features of LEFM?
70. What is the crack propagation criterion according to LEFM?
71. What is the relation between fracture toughness and fracture energy according to LEFM?
72. Which materials have very high fracture energies? How do you think these materials normally fail?

73. How is the fracture energy and type of failure affected by temperature, rate of loading and triaxiality?
74. What is the process of crack extension in a metal?
75. A metal with a higher yield strength will generally fail in a more brittle manner. Can you explain why? {Hint: use the equation giving the width of the plastic zone.}
76. The size of the plastic zone in a metal sheet is larger on the surface than inside. Why?
77. What is crazing? What is its role during the crack propagation in polymers?
78. What are the different phenomena in the fracture process zone of concrete?
79. Describe the Dugdale-Barenblatt model.
80. What are the crack initiation and propagation criteria according to the Hillerborg's fictitious crack model?
81. Why is the tensile strength of brittle materials characteristically low?
82. Why is the tensile strength of a brittle material like rock low compared to its compressive strength?
83. Which will have higher variability - compressive strength or tensile strength of concrete? Why?
84. The tensile strength of a longer rod will be generally less than a shorter one. Why?
85. A thinner glass fibre will have higher strength than a much thicker one. Why?
86. What is the Weibull modulus? What does a value of 100 imply?
87. Why should structural failure due to fracture be avoided?
88. What are the elements of the Maxwell and Kelvin models for rheology? Derive the governing equations.
89. What is a rheometer or viscometer used for?
90. How will the viscosity of a liquid, such as the oil used in a hydraulic actuator, change with pressure and temperature?
91. What is shear-thinning?
92. What is thixotropy?
93. What are the parameters of the Bingham model?
94. How is the apparent viscosity of a liquid different from its "actual" viscosity?
95. What are some microstructural features that can cause shear-thinning in a liquid? What is the condition that these features have to satisfy for thixotropy to occur?
96. Give examples of shear-thinning, shear-thickening and Newtonian fluids.
97. Give examples of thixotropic materials used in civil engineering. How does this particular aspect of its behaviour benefit their application?
98. Paint should be shear-thinning to be effective. Why?
99. What are the important thermal properties of a construction material?
100. Should the specific heat be high or low for a material to be beneficial in an application such as the wall of a house?
101. What is thermal expansion? Why does it happen?
102. Linear polymers have higher thermal expansion than heavily crosslinked ones. Why?
103. What is special about invar that it is used as a reference in measurements?
104. What is thermal shock?
105. How can thermal expansion give rise to stresses in a body?
106. The thermal conductivity of copper-zinc alloys decreases with an increase in zinc content. Why?