



UNIVERSITY OF GHANA

(All rights reserved)

BSc. MATERIALS SCIENCE AND ENGINEERING

FIRST SEMESTER EXAMINATION: 2016/2017

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING



MTEN 301: MATERIALS LABORATORY (1 Credit)

TIME ALLOWED: TWO HOURS (2 HRS)

INSTRUCTION: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

1. Table 1 contains the particle size distribution of two different clays; Abonko Clay and Legonite Clay.

Table 1: Sieving Analysis of Abonko and Legonite clays

ABONKO CLAY		LEGONITE CLAY	
Particle Size (μm)	% Weight Present	Particle Size (μm)	% Weight Present
50	5	800	10
100	10	1000	10
300	15	1200	30
450	25	1400	25
600	45	1600	25

- (a) (i) Draw a cumulative plot of the data above and compute the following: average particle size, median particle size, and first to final quartiles particle size range. [9 marks]
- (ii) Which of the two clays will require more water to form a plastic mass, given that the same weights of the two clays were used? Explain your answer. [3 marks]
- (b) Given that the bulk density of a ceramic composite is denoted by S_a and the specific gravity of the particles of the composite is denoted by S_t . Prove that the true porosity, P_t , of the composite is given as below:
$$(1 - S_a/S_t) \times 100$$
 [6 marks]
- (c) Under what conditions of a fired ceramic composite does $(P_t - P_a) = 0$ hold well? Note that P_t is true porosity and P_a is apparent porosity. [2 marks]

2.

(a) A titanium pipe used to transport a corrosive material at 400 °C is found to fail after several months. How would you determine the cause for the failure?

[5 marks]

(b) Briefly explain three mechanisms of hardening of a material system.

[6 marks]

(c) Give a brief explanation of the differences in fracture behavior between body centered cubic (BCC) structured metals and face centered cubic (FCC) structured metals as temperature increases.

[4 marks]

(d) With the help of a diagram, briefly explain the effects of stress levels on the shape of creep curves at a constant temperature.

[5 marks]

3.

(a) Sketch and describe briefly the creep curve.

[5 marks]

(b) State four engineering applications where the use of materials with high creep resistance is highly recommended.

[4 marks]

(c) Briefly describe how to design a test sample or specimen for the Charpy impact test.

[5 marks]

(d) Draw a schematic diagram showing the development of strain in an elastic, viscoelastic and Rubbery (Elastomers) material. Assume that the load is applied at some time $t = 0$ and taken off at some time t .

[6 marks]

4.

(a) A crankshaft in a diesel engine fails. Examination of the crankshaft reveals no plastic deformation. The fracture surface is smooth. In addition, several other cracks appear at other locations in the crankshaft. What type of failure mechanism occurred?

[5 marks]

(b) An investigation of fracture behavior in body centered cubic (BCC) structure metals is concerned with the ductile to brittle transition temperature (DBTT) curve obtained from the results of a number of tests performed under different temperatures in the Charpy impact test. Sketch and describe the curve.

[6 marks]

(c) State four engineering applications where hardness test is applied.

[4 marks]

(d) How would you measure the hardness of an unmovable part of a large machine which is very heavy to transport?

[5 marks]