FACULTY OF MECHANICAL ENGINEERING
UNIVERSITI TEKNOLOGI MALAYSIA

SAMPLE TEST 1
SEMESTER I, 2014/2015

COURSE CODE : SKMM 4133
COURSE NAME : FAILURE OF ENGINEERING COMPONENTS
PROGRAM : SMM
TEST DURATION : 1 HOUR 30 MINUTES
DATE ISSUED : 19 OCTOBER 2014

INSTRUCTION TO CANDIDATES:

ANSWER ALL QUESTIONS WITHIN THE ALLOCATED TIME
SUBMIT YOUR ANSWER SCRIPTS ON 26 OCTOBER 2014

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THIS TEST PAPER CONSISTS OF FOUR PAGES INCLUDING THIS COVER PAGE
Question 1

(a) Give one example of engineering component failure resulting from processing defect of the component material. Elaborate how the defect leads to final fracture of the component while in service.

(b) Preliminary failure investigation is to be carried out on a failed hanger assembly shown in Figure Q1. The failed 12-mm diameter bolt at Bis made of steel with shear strength of 100 MPa. Tensile strength of the 15-mm diameter rod AB is 150 MPa. Service records showed that the assembly sustained a distributed load, \( w = 7.2 \text{ kN/m} \) during the failure event.

(i) Perform stress analysis on the failed bolt. Can you conclude the cause of failure based on results of your calculations?

(ii) Suggest an improvement on the design of the hanger assembly to prevent similar failure of the assembly when carrying identical load magnitude in the future. Justify your recommendation.

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Figure Q1
Question 2

The fracture process of a ductile material under tensile loading condition is illustrated in Figure Q2. Briefly describe the chronology of the failure process at each stage of loading using the figures.

(You may use the following keywords / phrases, as applicable)

Cup and cone fracture  
Void nucleation  
Necking  
Voids coalescence  
Shear band formation  
Monotonic loading  
Ductile fracture  
Dimples  
Cracks

Figure Q2
Question 3

Stress analysis is performed on a fractured shaft, shown in Figure Q3. The fracture plane is located at section B. The surface of the shaft at the fracture area is ground. The shaft is made of BS826 M40 HT steel with tensile and yield strength of 1300 and 850 MPa, respectively. The fatigue limit of the material for smoothed specimen can be estimated as, $S_e' = 0.5S_{ut}$

i) Sketch the fatigue stress cycles experienced by the material point at the fracture location. Indicate the magnitude of stress amplitude and load ratio.

ii) Based on your analysis, suggest and justify the possible cause of failure.

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Dimensions in mm. All fillets radii are 3 mm.

Figure Q3

(Refer to published information in textbooks – J.E. Shigley (Mechanical Engineering Design) and R.I Spethens et al. (Metal Fatigue in Engineering) for related information)