# TECHNICAL UNIVERSITY OF MOMBASA

## Faculty of Engineering and Technology
DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

## UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATION 2013/2014

FIFTH YEAR SECOND SEMESTER UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

## EMG 2519    :    MAINTENANCE ENGINEERING AND INDUSTRIAL SAFETY

**TIME:** 2 HOURS                                    **SERIES:** MARCH, 2014

### INSTRUCTIONS TO CANDIDATES

1.    You are required to have the following for these examinations:
   - Drawing Instruments
   - Scientific  Calculator

2.  This paper has **FIVE** Questions.
3.  Answer **ONE** Question from Section **A** and other **TWO** Questions from Section **B**
4.  All relevant tables and formulae have been provided on the question paper.
5.  All symbols have their usual meaning.
6.  This paper consists of **FIVE** *Printed pages.*
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SECTION A  :        Answer **ONE** Question from this Section

### QUESTION 1

(a)    The OSHA act sets out the requirements of fittings and attachments to boilers.  Describe the four mandatory attachments that should be affixed to boilers and steam receivers.
                                                                                    **(8 marks)**

(b)    Describe the **FOUR** requirements on ergonomics at the workplace, as defined by the OSHA act.                                                    **(4 marks)**

(c)     A supermarket stocks in a variety of goods, most of which are how hold goods; furniture, clothing, consumables (food and A occupies a very large floor area).

    (i)     Analyze a few safety critical aspects of this supermarket.     **(5 marks)**

    (ii)    What type of fire fighting system would you recommend, and why? **(3 marks)**


**QUESTION 2**

(a)     FMEA and FMECA utilize categories and levels of failure to show the criticality of a given malfunction.

    (i)     Describe the four failure categories used in FMECA.     **(8 marks)**

    (ii)    What are failure levels used for?     **(1 mark)**


(b)    (i)     Describe the three categories of tasks that are associated with maintenance management.

    (ii)    Shirt any **SIX** key features of a cmms.

                                          **(3 marks)**

(c)     Allocate the system reliability goal of 0.99 to the components of the reliability block diagram on Figure 1 below.  Assume an equal allocation to each redundant subset.  Each subset contains identical components.
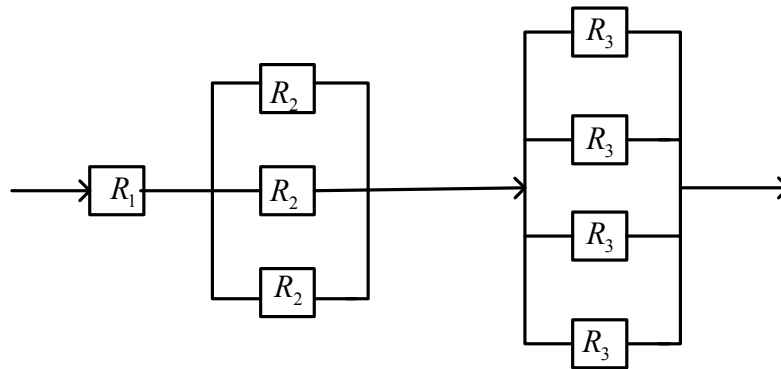


**Fig. 1**

                                                        **(8 marks)**

**SECTION B :** Answer **ANY TWO** Questions from this Section

## QUESTION 3

(a)  (i)  Describe the **SIX** categories of fires that may occur in an industry. **(6 marks)**

  (ii)  Explain the factors determining the application of either dry risers or wet risers in fire fighting. **(4 marks)**

(b)  (i)  Identify the **TWO** key elements of fire protection. **(4 marks)**

  (ii)  Describe the key aspects considered in the design of vertical escape routes. **(6 marks)**

Q.4  (a)  A flange bolt wears out because of fatigue in accordance with the lognormal with MTTF = 10 00 HRS, and s = 2.0. If the preventive maintenance consists of periodically replacing the bolt,

  (i)  Determine the reliability at 550hrs with and without preventive maintenance. Assume the bolts are to be replaced every 100 hours. **(5 marks)**

  (ii)  Determine the maintenance interval of a reliability of 0.99 is to be implemented. **(3 marks)**

(b)  (i)  Show how the shape parameter influences the behavior of the weiball distribution. **(4 marks)**

  (ii)  A car engine has four belts which exhibit a weibull pattern. The scale parameter is 1.4, while the shape parameters are 2500, 3400, 8000 and 6,000. The generating hours are 6100. If the operating hours are at 0, determine the probability of a belt failure on a 100hr trip. **(6 marks)**

(c)  List the various components of maintenance downtime. **(2 marks)**

Q.5 (a) Show that the constant failure rate is a memoryless function. **(4 marks)**

(b) Reliability centered maintenance is normally implemented by administering questions on maintenance and failure on each component. Identify these analysis questions. **(7 marks)**

(c) Two systems SI and SII used for a similar purpose have the following descriptions:

SI - Two CFR components linked in parallel, each having an MTTF of 1,000 hrs.

SII - One Weibull component with a shape parameter of 2 and a scale parameter of 10,000 hrs, in series with a CFR. Component with a failure rate of 0.00003.

Establish which of the two systems has a higher reliability at the end of 1,000 operating hours.

**(6 marks)**

(d) Given a system with a CFR of:
$$\lambda(t) = 0.0005t^{0.8}; \quad t \geq 0$$
Determine the system's reliability if a preventive maintenance program is conducted annually.

**(3 marks)**