
UNIVERSITI SAINS MALAYSIA

First Semester Examination
2013/2014 Academic Session

December 2013 / January 2014

EEM 423 – RELIABILITY ENGINEERING
[KEJURUTERAAN KEMAMPUAN]

Duration 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **SIX (6)** pages and Appendix **TWO (2)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **ENAM (6)** muka surat dan Lampiran **DUA (2)** muka surat bercetak sebelum anda memulakan peperiksaan ini]*

Instructions: This question paper consists **FIVE (5)** questions. Answer **ALL** questions. All questions carry the same marks.

Arahan: Kertas soalan ini mengandungi **LIMA (5)** soalan. Jawab **SEMUA** soalan. Semua soalan membawa jumlah markah yang sama]

Answer to any question must start on a new page.

[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru]

“In the event of any discrepancies, the English version shall be used”.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai]

1. (a) Terangkan maksud istilah yang berikut yang digunakan dalam kejuruteraan reliabiliti dan beri lakaran yang sesuai.

Explain the meanings of the following terms used in reliability engineering, and provide suitable sketches.

(i) Fungsi reliability
Reliability function (20 markah/marks)

(ii) Fungsi taburan kumulatif
Cumulative distribution function (20 markah/marks)

- (b) Terangkan hubungan antara fungsi reliabiliti dan fungsi taburan kumulatif. Beri lakaran yang sesuai.

Explain the relationship between the reliability function and the cumulative distribution function. Provide a suitable sketch.

(10 markah/marks)

- (c) Diberi fungsi ketumpatan kebarangkalian yang berikut, di mana t merujuk kepada bilangan jam

Given the following probability density function, with t in hours,

$$f(t) = \begin{cases} 0.0002e^{-0.0002t} & t \geq 0 \\ 0 & \text{Sebaliknya/otherwise} \end{cases}$$

tentukan perkara yang berikut. Beri interpretasi bagi jawapan anda untuk bahagian (iii) hingga (v)

determine the following items. Interpret your answers for parts (iii) to (v).

- (i) Fungsi reliability
Reliability function
 - (ii) Fungsi taburan kumulatif
Cumulative distribution function
 - (iii) MTTF dan intepretasinya
MTTF and its interpretation
 - (iv) Median dan intepretasinya
Median and its interpretation
 - (v) Mod dan intepretasinya
Mode and its interpretation
- (50 markah/marks)

2. (a) Lima unit pemampat diuji hingga kesemua unit gagal. Masa kegagalan (dalam jam) adalah seperti berikut : 32, 51, 74, 90, and 120. Tentukan secara grafikal sama ada masa kegagalan tersebut datang daripada taburan Weibull. Jika ia, anggarkan nilai kesemua parameter taburan.

Five compressor units are tested until all of the units fail. The failure times were (in hours) : 32, 51, 74, 90 and 120. Graphically determine if the failure times comes from the Weibull distribution. If so, estimate the values of all of the parameters for the distribution.

(40 markah/marks)

- (b) Apakah yang dapat diperkatakan mengenai kelakuan sebuah proses kegagalan jika taburan Weibull yang mempunyai $\beta=2$ dan $\theta=4$ didapati memberi padanan yang baik untuk data kegagalan bagi proses tersebut?

What can be said regarding the behavior of a failure process if a Weibull distribution with $\beta=2$ and $\theta=4$ was found to provide a good fit for the failure data obtained from the process?

(20 markah/marks)

- (c) Terangkan mengapa taburan kegagalan Weibull merupakan taburan yang berguna dalam kejuruteraan reliabiliti.

Explain why the Weibull failure distribution is a useful distribution in reliability engineering.

(40 markah/marks)

3. (a) Apakah sumber data reliabiliti?

What are the sources of reliability data?

(40 markah/marks)

- (b) Bagaimanakah jaminan reliabiliti proaktif berbeza daripada jaminan reliabiliti tradisional?

How does proactive reliability assurance differ from traditional reliability assurance?

(30 markah/marks)

- (c) Kenapa jaminan reliabiliti proaktif lebih efektif daripada jaminan reliabiliti tradisional? Beri contoh yang sesuai.

Why is proactive reliability assurance more effective than traditional reliability assurance? Give relevant examples.

(30 markah/marks)

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4. (a) Bincang dan bandingkan secara grafik reliabiliti sistem berikut untuk $p=0.9$ dan $p=0.8$ di mana p ialah reliabiliti setiap komponen.

Discuss and compare graphically the reliabilities of the following systems for $p=0.9$ and $p=0.8$, where p is the reliability of each component.

(i) 4 komponen sistem selari
4 component parallel system

(ii) Sistem 2-dari-4
2-out-4 system

(iii) Sistem 3-dari-4
3-out-4 system

(iv) 4 komponen sistem siri
4 component series system

(60 markah/marks)

- (b) Untuk sistem 2-unit, bincang dan bandingkan reliabiliti sistem jika mereka dipasang seperti berikut:

For a 2-unit system, discuss and compare the system reliability if they are arranged as in the following configurations:

(i) Mod Selari
Parallel mode (Active)

(ii) Mod 'Standby'
Standby mode

Penerangan mesti dibantu dengan lakaran grafik.

Explanation must be supported with graphical sketch

(40 markah/marks)

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5. (a) Terang dan bandingkan berikut: ESS, BURN-IN, Accelerated testing, HALT dan HASS. Terangkan aplikasi mereka dalam pelbagai fasa produk dari fasa rekabentuk hingga ke fasa pengeluaran.

Explain and compare the following reliability tests: ESS, BURN-IN, Accelerated testing, HALT and HASS. Describe their application in different stages of product from design to production stage.

(40 markah/marks)

- (b) Terangkan sebutan berikut dalam ujian terpecut

Explain the following terms in accelerated test

- (i) model hayat-tegasan

Life-Stress model

- (ii) Pembebanan tegasan

Stress loading

(20 markah/marks)

- (c) Terang bagaimana suhu digunakan untuk memecut satu pengujian. Terang dengan menggunakan satu contoh proses bagi memecutkan pengujian termasuk pembebanan tegasan, model hayat-tegasan dan perkara yang berkaitan.

Explain how temperature can be used to accelerate the testing? Explain by giving an example the process of accelerating test using the temperature, including stress loading, life-stress model, and all related matters .

(40 markah/marks)