UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EBB 405/3 – Failure Analysis & Non-Destructive Testing
[Ujian Kegagalan & Ujian Tak Musnah]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains ELEVEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of FIFTEEN questions from PART A, THREE questions from PART B and THREE questions from PART C.
[Kertas soalan ini mengandungi LIMA BELAS soalan dari BAHAGIAN A, TIGA soalan dari BAHAGIAN B dan TIGA soalan dari BAHAGIAN C.]

Instruction: Answer **ALL** questions from PART A, **TWO** questions from PART B and **TWO** questions from PART C. If candidate answers more than four questions only the first four questions answered in the answer script would be examined.
*[**Arahan**: Jawab **SEMUA** soalan pada BAHAGIAN A, **DUA** soalan pada BAHAGIAN B dan **DUA** soalan pada BAHAGIAN C. Jika calon menjawab lebih daripada empat soalan hanya empat soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all question must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

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.]

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PART A / *BAHAGIAN A*

1. What are the factors which contribute to the quality of a visual inspection?

   Apakah faktor-faktor yang memberikan kualiti ujian visual?

   (10 marks/*markah*)

2. How many percent is the minimum discernible difference in gray scale level that the eye can detect?

   Berapa peratuskah perbezaan pengesanan yang boleh dikesan oleh mata dalam aras skala kelabu?

   (10 marks/*markah*)

3. What are the criteria a vision operator must have to get the best visual results for a certain sample?

   Apakah sifat-sifat mesti terdapat pada seseorang operator visual untuk mendapatkan keputusan visual terbaik?

   (10 marks/*markah*)

4. The ability to locate a small discontinuity in ultrasound testing is called?

   Kebolehan mencari kecacatan kecil di dalam ujian ultra bunyi dipanggil?

   (10 marks/*markah*)

5. What can be said about a material with a wider magnetic hysteresis loop?

   Apakah yang boleh dikatakan berkenaan bahan yang mempunyai gelung histerisis magnetik yang lebar?

   (10 marks/*markah*)

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6. Briefly explain three important characteristics of a liquid penetrant.

Terangkan secara ringkas tiga ciri-ciri penting bagi cecair penusukan.

(10 marks/*markah*)

7. What is the role of developer in liquid penetrant testing. List three types of developer and compare their sensitivity.

Apakah fungsi pemaju dalam ujian cecair penusukan. Senaraikan tiga jenis pemaju dan bandingkan dari segi kesensitifan.

(10 marks/*markah*)

8. Explain three similar properties of X-rays and gamma rays.

Terangkan tiga persamaan sifat sinar- X dan sinar gamma.

(10 marks/*markah*)

9. Discuss why undercut must often be controlled when producing radiographs.

Bincangkan mengapa "undercut" mesti selalu dikawal apabila menghasilkan radiografi.

(10 marks/*markah*)

10. Briefly explain why radiation beam filters are sometime used in X-ray radiography.

Terangkan secara ringkas kenapa penapis alur radiasi kebiasaannya digunakan dalam radiografi sinar- X.

(10 marks/*markah*)

11. The inductive reactance of the coil decreases as the severity of the flaw increases. Give your comment and justification if any.

Reaktan aruhan bagi gegelung akan berkurangan apabila severiti kecacatan bertambah. Berikan komen anda dan justifikasi jika berkaitan.

(10 marks/*markah*)

12. What did you understand about lift-off in eddy current testing?

Apakah yang anda faham berkenaan "lift-off" dalam pengujian arus pusar?

(10 marks/*markah*)

13. Impedance diagrams help us understand the complex nature of eddy currents. How is it being used?

Diagram impedan boleh membantu dalam pemahaman natur arus pusar. Bagaimanakah ianya digunakan.

(10 marks/*markah*)

14. The degree of filling is the ratio of material cross-sectional area to coil cross-sectional area. Give your comment.

Darjah pengisian adalah nisbah di antara luas keratan rentas bahan kepada luas keratan rentas gegelung. Berikan komen anda.

(10 marks/*markah*)

15. What is the effect of frequency response to eddy current penetration?

Apakah kesan respon frekuensi kepada penusukan arus pusar?

(10 marks/*markah*)

PART B / *BAHAGIAN B*

1. [a] What does it mean by acoustic impedance?

Apakah yang dimaksudkan dengan impedan akustik?

(20 marks/*markah*)

[b] Why is acoustic impedance important in an ultrasonic study?

Kenapa impedan akustik penting dalam kajian ultrabunyi?

(30 marks/*markah*)

[c] Calculate and sketch the reflection and transmission energy.

Kira dan lakarkan tenaga terpantul dan penghantaran.

(i) When does sound travel through water and titanium?

Bilakah bunyi boleh bergerak melalui air dan titanium?

[ρ_{water} = 1.000 g/cm^3, $\rho_{titanium}$ = 4.5 g/cm^3, V_{water} = 0.148 cm/μs, $V_{titanium}$ = 0.607 cm/μs]

(25 marks/*markah*)

(ii) When does sound travels through stainless steel and nickel?

Bilakah bunyi boleh bergerak melalui bahan keluli tahan karat dan nikel?

[$\rho_{stainless\ steel}$ = 7.800 g/cm^3, ρ_{nickel} = 8.880 g/cm^3, $V_{stainless\ steel}$ = 0.579 cm/μs, V_{nickel} = 0.563 cm/μs]

(25 marks/*markah*)

2. [a] Explain in full detail the out door radiography welding inspection.

Terangkan dengan terperinci tentang pemeriksaan radiografi kimpalan di lapangan.

(40 marks/*markah*)

[b] A technician operates an x-ray radiographic machine at a current of 80 mA. The exposure time is set for 50 sec and the distance between the source of x-ray and the sample is 50 cm.

(i) What is the exposure factor?

(ii) Estimate the accumulated dose of radiation in the technician's body in eight month at a normal working distance R = 15 meter from the source.

Take the following information: The dose rate measured near the machine Do=5mrem/hour at a distance of Ro=20cm from the x-ray source.

Seorang juruteknik mengendalikan mesin radiografi sinaran-x pada arus sebanyak 80 mA. Masa dedahan adalah dilaraskan pada 50 saat dan jarak di antara punca sinaran-x dan sampel adalah 50 sm.

(i) Apakah faktor dedahan.

(ii) Anggarkan dos terkumpul bagi sinaran dalam jasad juruteknik dalam masa lapan bulan pada jarak kerja normal R=15 meter daripada punca.

Ambil maklumat berikut: Kadar dos disukat berhampiran dengan mesin Do=5mrem/jam pada jarak Ro=20sm daripada sumber sinaran-x.

(60 marks/*markah*)

3. [a] With proper sketches, demonstrate the effect of conductivity on coil impedance in eddy current measurement.

Dengan lakaran yang bersesuaian, tunjukkan kesan konduktiviti ke atas impedan gegelung dalam pengujian arus pusar.

(40 marks/*markah*)

[b] Relate signal to noise ratio in eddy current testing.

Hubungkaitkan nisbah isyarat kepada gangguan dalam ujian arus pusar.

(20 marks/*markah*)

[c] Some hypothetical metal is known to have an electrical resistivity of 4 X 10^{-8} (ohm-m). Through a specimen of this metal that is 25 mm thick is passed a current of 30 A; when a magnetic field of 0.75 tesla is simultaneously imposed in a direction perpendicular to that of the current, a Hall voltage of -1.26 X 10^{-7} V is measured. Compute the electron mobility for this metal.

Beberapa logam hipotektikal diketahui mempunyai resistiviti elektrikal sebanyak 4 x 10^{-8} ohm-m. Satu spesimen logam ini dengan ketebalan terus 25 mm dialirkan arus sebanyak 30A; apabila suatu medan magnetik sebanyak 0.75 tesla secara serentak dikenakan dalam arah bersudut tegak terhadap arus, voltan Hall sebanyak -1.26 x 10^{-7} V adalah disukat. Kirakan kelincahan elektron bagi logam ini.

(40 marks/*markah*)

PART C / *BAHAGIAN C*

4. [a] What is the best magnetic particle inspection method to find a defect on a ceramic tile?

Apakah kaedah ujian butiran magnet terbaik untuk mencari kecacatan pada jubin seramik?

(10 marks/*markah*)

[b] What is the best magnetic particle inspection method to find a defect on an iron plate with an area of 5 x 5 m^2?

Apakah kaedah ujian butiran magnet terbaik untuk mencari kecacatan pada kepingan besi bersaiz 5 x 5 m^2?

(10 marks/*markah*)

[c] Based on your answer in Question 4 [b], indicate why you chose this method?

Berdasarkan jawapan anda dalam Soalan 4 [b], nyatakan kenapa anda memilih kaedah ini?

(30 marks/*markah*)

[d] Based on your answer in Question 4 [b], explain the procedures/steps of this method.

Berdasarkan jawapan anda dalam Soalan 4 [b], terangkan prosedur-prosedur/langkah-langkah kaedah ini.

(50 marks/*markah*)

5. [a] Compare these three processes, and discuss the advantages and disadvantages of each:

(i) water washable fluorescence penetrant process.

(ii) post-emulsification fluorescent process.

(iii) Solvent clean visible die penetrant process.

Bandingkan tiga proses berikut, dan bincangkan kelebihan dan kekurangan setiap proses:

(i) Proses penusukan floresen terbasuh air.

(ii) Proses floresen lepas-emulsifikasi.

(iii) Proses penusukan dai visible bersih pelarut.

(40 marks/*markah*)

[b] Briefly discuss three types of defects that can be detected by liquid penetrant inspection.

Bincangkan secara ringkas tiga jenis kecacatan yang boleh dikesan secara efektif dengan pemeriksaan penusukan cecair.

(30 marks/*markah*)

[c] Define dwell time. Briefly explain effect of the minimum penetrant dwell time, under dwell time and extended dwell time on the inspection results.

Berikan definasi masa enapan. Terangkan secara ringkas masa enapan penusukan minimum, masa enapan kurang dan pemanjangan masa enapan ke atas keputusan pemeriksaan.

(30 marks/*markah*)

6. [a] Explain what the meaning of Failure Analysis in term of analyzing failure component.

Terangkan apakah yang dimaksudkan dengan Analisis Kegagalan dari segi analisis komponen yang gagal.

(5 marks/*markah*)

[b] Give the proper steps used in order to evaluate or investigate Failure Analysis of a material defect. You may explain in process flow format and give a full explanation on every step.

Berikan langkah-langkah yang betul dalam menilai atau menyiasat analisis kegagalan bagi satu bahan yang cacat. Anda boleh menerangkan dalam format cartalir proses dan berikan penjelasan lengkap bagi setiap langkah.

(30 marks/*markah*)

[c] Based on the statement below, write a full Failure Analysis Report.
Live high voltage power transmission cables fell onto the ground in Sarawak when failure occurred in cast iron caps on the insulator string. This threatened lives, as well as disrupting power supplies over a large area. The issues here relate to explaining how a relatively low energy arc-over between adjacent caps could occur and cause the cap to 'burst', allowing the insulator string to fall to the ground with the live cable. The discussion should also considering crack initiation, heat treatment, microstructure and toughness in ferritic malleable iron. Refer to Figure 1 and Figure 2 for the schematic of the insulator construction and fractured cap, respectively.

Berdasarkan kenyataan di bawah, tuliskan satu laporan analisis kegagalan yang lengkap.

Satu kabel transmissi kuasa voltan tinggi yang hidup jatuh ke atas tanah di Sarawak di mana kegagalan adalah berlaku ke atas tukup besi tuangan di atas dawai penebat. Ini adalah menggugat nyawa, dan juga menyebabkan gangguan bekalan kuasa bagi satu kawasan yang luas. Isunya disini adalah berkenaan penerangan bagaimana secara relatifnya, arka berkuasa rendah ke atas tukup berdekatan boleh berlaku dan menyebabkan tukup tersebut "pecah", menyebabkan dawai penebat jatuh ke tanah dengan kabel hidup. Perbincangan mestilah juga mempertimbangkan permulaan retak, rawatan haba, mikrostruktur dan keliatan bagi besi tuangan feritik. Rujuk kepada Rajah 1 dan Rajah 2 masing-masing bagi skematik pembinaan penebat dan tukup yang pecah.

Figure 1 is a schematic of insulator construction and Figure 2 shows a fractured cap.

Rajah 1 adalah pembinaan penebat dan Rajah 2 adalah tukup dengan kegagalan

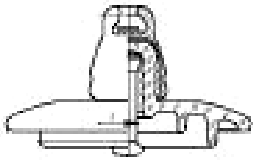

Figure 1: Insulator construction
Rajah 1: Pembinaan penebat

Figure 2: Fractured cap
Rajah 2: Tukup yang pecah

(65 marks/*markah*)

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