UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2004/2005

October 2004

EBB 405E/3 – Failure Analysis And Non-Destructive Testing
[Penyiasatan Kegagalan Dan Ujian Tak Musnah]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of TWENTY FOUR pages of printed material and TWO pages APPENDIX [Answer Sheet For Objective Question And Answer Sheet For True or False Question] before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA PULUH EMPAT muka surat bercetak dan DUA muka surat LAMPIRAN [Kertas Jawapan Objektif dan Kertas Jawapan Betul atau Salah] sebelum anda memulakan peperiksaan.

This paper contains THIRTY TWO Objective Questions and FIFTEEN True or False Questions in Section A and SIX Subjective Questions in Section B.

[Kertas soalan ini mengandungi TIGA PULUH DUA Soalan Objektif dan LIMA BELAS Soalan Betul atau Salah dalam Bahagian A dan ENAM Soalan Subjektif dalam Bahagian B].

Instructions: Answer **ALL** questions from Section A (Compulsory) and **FOUR** other questions from Section B.

*[**Arahan:** Jawab **SEMUA** soalan daripada Bahagian A (Wajib) dan mana-mana **EMPAT** soalan daripada Bahagian B].*

Answer to any Subjective questions must start on a new page. For the Objective and True or False type questions, make use of the answer sheet as provided in the Appendix.

[Mulakan jawapan anda untuk setiap soalan subjektif pada muka surat yang baru. Bagi soalan Objektif dan Betul atau Salah, gunakan kertas jawapan yang disediakan dalam Lampiran].

All questions must be answered in English language. However, ONE question can be answered in bahasa Malaysia.

[Semua soalan mesti dijawab dalam bahasa Inggeris. Walau bagaimanapun, SATU soalan dibenarkan dijawab dalam bahasa Malaysia].

...2/-

SECTION A

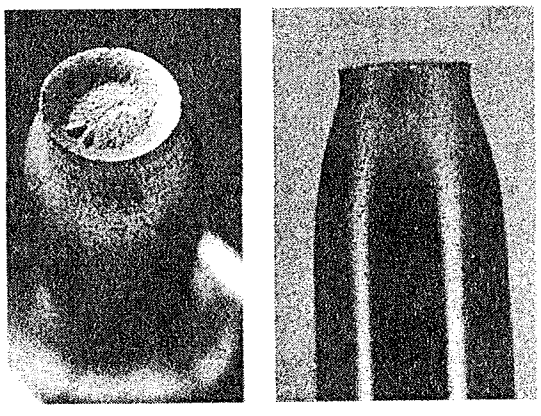
BAHAGIAN A

From 1 to 32 select the most appropriate answer(s).

1. The protective spray in a liquid dye penetrant can be removed later using:
   A. Trichloroethylene.
   B. Water.
   C. Acetone.
   D. Oil.

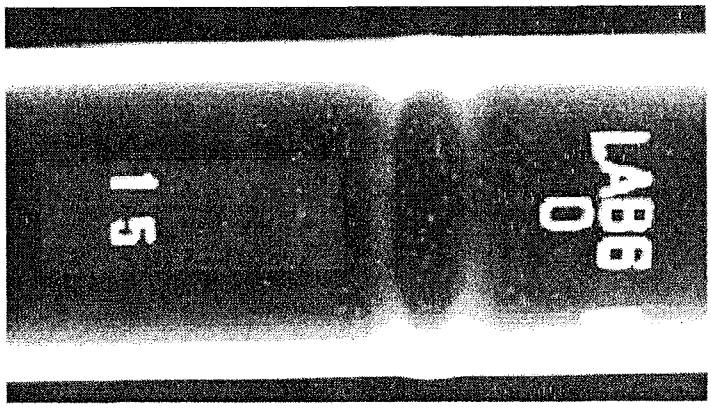
2. In any failure analysis investigation some features should be recorded. These include:
   A. Origin of Failure.
   B. Location of stress concentrators.
   C. Direction of crack propagation.
   D. All of the above.

3. The fracture surface below is:



   A. Creep fracture.
   B. Ductile.
   C. Brittle.
   D. Fatigue.

4. The radiographic bellow is



A. Weld spatter.

B. External Under cut.

C. Burn through.

D. Scatter Porosity.

5. Vapour degreasing is used to remove organic contaminants such as:

A. Varnish.

B. Rust.

C. Grease.

D. All of the above

6. If the wrong cleaning material is used; the component may be damaged due to:

A. Rusting.

B. Residue on the surface.

C. Corrosion.

D. All of the above.

7. When using shot or grit blasting, it is important to remember that the blasting operation may:

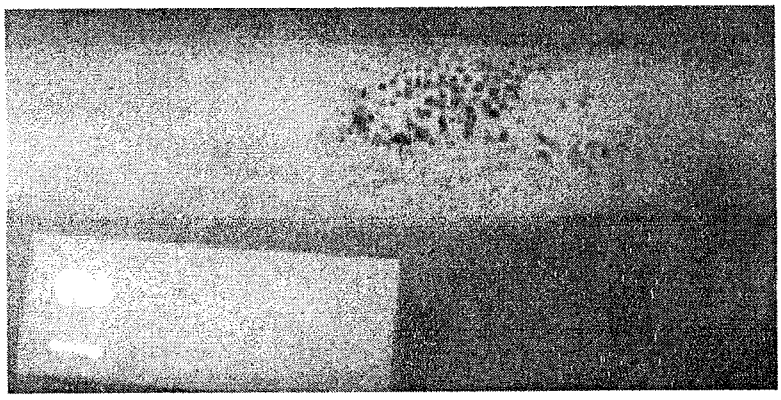
A. Peen over the metal.

B. Etch the metal.

C. Stress the metal allowing premature cracking.

D. Detect subsurface discontinuities.

8. The radiographic bellow is



A. Cluster Porosity.

B. Random Porosity.

C. External Undercut.

D. Internal Undercut.

9. Small holes or threaded parts may be plugged with a small amount of:

A. Varnish.

B. Penetrant.

C. Paint.

D. Nonferromagnetic material.

10. When a component has not been magnetized:

A. The magnetic domains are not orientated in any particular direction.

B. The magnetic domains are aligned between the north and south poles.

C. The magnetic domains repel each other.

D. The component becomes more conductive.

11. The objective of magnetic particle testing is to:

A. Obtain a visual image of an indication on the surface of a material.

B. Disclose the nature of a discontinuity without impairing the part's usefulness.

C. Determine acceptable from rejectable discontinuities.

D. All of the above apply.

12. The north and south poles of a magnet will:

A. Repel each other.

B. Attract towards each other.

C. Attract or repel depending on the orientation of the domains.

D. Create a flux capacitance.

13. Which type of material has a slight repelling effect when a magnetic field is applied?

A. Diamagnetic materials.

B. Paramagnetic materials.

C. Ferromagnetic materials.

D. Sterromagnetic materials.

14. A crack will disrupt the lines of force creating:

A. Flux leakage.

B. Coercive force.

C. Magnetic flux.

D. Resistive force.

15. The ease in which a material can be magnetized is called:

A. Permeability.

B. Reluctance.

C. Residual magnetism.

D. Retentivity.

16. High carbon steel that has been magnetized would have:

A. High permeability.

B. Low reluctance.

C. Low residual magnetism.

D. High coercive force.

17. Low carbon steel that has been magnetized would have:

A. High permeability.

B. High reluctance.

C. High residual magnetism.

D. High coercive force.

18. A circular magnetic field can be induced into a component by:

A. Direct induction.

B. Central induction.

C. Reverse induction.

D. Residual induction.

19. What direction are the magnetic lines of force in relation to the direction of the current?

A. 25 degrees.

B. 45 degrees.

C. 90 degrees.

D. 100 degrees.

20. Which of the following produce a circular magnetic field?

A. Contour probe.

B. Coil.

C. Prods.

D. All of the above.

21. The most common application of penetrant is by:

A. Dipping.

B. Spraying.

C. Swabbing.

D. Only A and B.

22. Emulsification times can vary from:

A. 15 seconds to 5 minutes.

B. 5 to 10 minutes.

C. 5 seconds to 10 minutes.

D. 5 to 15 minutes.

23. If stress corrosion is suspected on material in liquid penetrant testing; what is the recommended emulsification time?

A. A minimum of 10 minutes.

B. A minimum of 30 minutes.

C. A minimum of 1 hour.

D. A minimum of 4 hours.

24. The more complicated the component:

A. The less time it will take to remove the excess penetrant.

B. The more time it will take to remove the excess penetrant.

C. The shorter the dwell time needed in order for the penetrant to enter discontinuities.

D. The longer the dwell time needed in order for the penetrant to enter discontinuities.

25. Emulsifiers used in liquid penetrant testing are:

A. Water based.

B. Oil based.

C. Solvent based.

D. Either water based or oil based.

26. Which type of emulsifier is supplied in concentrated form and requires dilution with water?

A. Hydrophilic emulsifier.

B. Lipophilic emulsifier.

C. Solvent removable emulsifier.

D. Aqueous emulsifier.

27. Wetting ability is:

A. The ability of a penetrant to cover the surface of the part.

B. The ability of a liquid to enter a discontinuity.

C. The ability to hold surface molecules together.

D. The adhesion required to hold the penetrant in place.

28. Solvent removable penetrants require:

A. An emulsifier.

B. Solvent applied to a clean lint free cloth and wiped over the surface of the component.

C. A water spray in order to remove the excess penetrant from the component surface.

D. All of the above may be used.

29. Which type of emulsifier works by dissolving the excess penetrant making it water washable?

A. Hydrophilic emulsifier.

B. Lipophilic emulsifier.

C. Solvent removable emulsifier.

D. Aqueous emulsifier.

30. The minimum temperature at which a liquid will ignite is called:

A. Ignition point.

B. Flash point.

C. Vapor point.

D. Fire point.

31. What type of chemical is used to make penetrants water washable?

A. Emulsifiers.

B. Organic chemicals.

C. Hydrophilics.

D. Solvents.

32. The most cost effective method used to dry components is a:

A. Warm air dryer.

B. Hand held air dryer.

C. Fan.

D. Hair dryer.

(70 marks)

Daripada 1 hingga 32, pilih jawapan yang bersesuaian.

1. Semburan pelindung boleh dibuang kemudian menggunakan

A. Tri-khloroethilene.

B. Air.

C. Aseton.

D. Minyak.

2. Dalam pemeriksaan analisis kegagalan beberapa ciri sepatutnya direkodkan. Ini termasuklah.

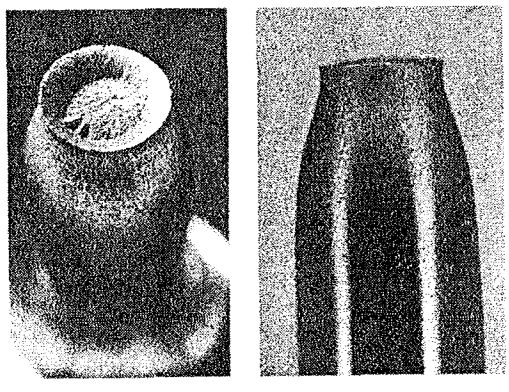
A. Asalan kegagalan.

B. Lokasi tumpuan tegasan.

C. Arah bagi perambatan retakan.

D. Semua di atas.

3. Permukaan patah di bawah adalah:



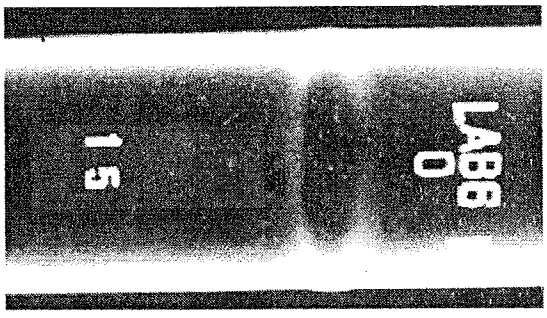
A. Patah rayapan.

B. Mulur.

C. Rapuh.

D. Lesu.

4. *Radiografik di bawah adalah:*



A. *Percikan kimpalan.*

B. *Kurang-potongan luaran.*

C. *Keseluruhan bakaran.*

D. *Keliangan tertabur.*

5. *Penyah-grisan wap digunakan dalam pembuangan bahan cemar organik seperti:*

A. *Varnis.*

B. *Karat.*

C. *Gris.*

D. *Semua di atas.*

6. *Sekiranya bahan cucian yang salah digunakan, komponen mungkin dimusnahkan disebabkan oleh:*

A. *Pengaratan.*

B. *Bakian di atas permukaan.*

C. *Kakisan.*

D. *Semua di atas.*

7. *Apabila menggunakan pembagasan butir ataupun grit, adalah penting diingatkan bahawa operasi pembagasan mungkin:*

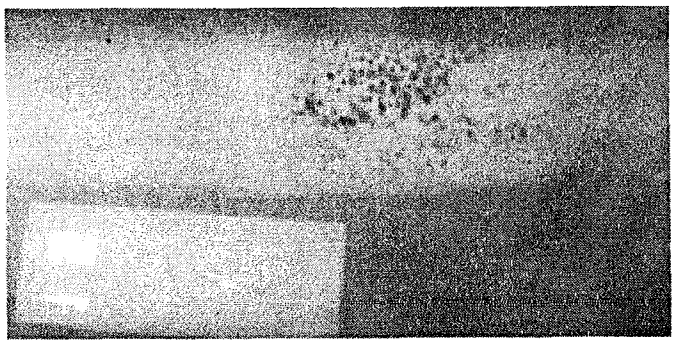
A. *Mengepin logam.*

B. *Memunar logam.*

C. *Menegang logam dan membenarkan retakan pra-matang.*

D. *Mengesan kecacatan bawah-permukaan.*

8. *Radiografik di bawah adalah:*



A. *Keliangan gugusan.*

B. *Keliangan rawak.*

C. *Makan-bawah luaran.*

D. *Makan-bawah dalaman.*

9. *Lubang kecil ataupun bahagian ulir mungkin boleh dipalam dengan sebahagian kecil:*

A. *Varnis.*

B. *Bahan Penusuk.*

C. *Cat.*

D. *Bahan tak-ferromagnetik.*

10. *Apabila satu komponen tidak dimagnetkan:*

A. *Domain magnetik tidak diorientasi dalam mana-mana arah tertentu.*

B. *Domain magnetik dijajarkan diantara kutub utara dan selatan.*

C. *Domain magnetik menolak antara satu sama lain.*

D. *Komponen menjadi lebih konduktif.*

11. *Objektif pengujian serbuk magnetik adalah untuk:*

A. *Memperolehi imej ternampakan bagi penanda pada permukaan bahan.*

B. *Menyingkap tabiat kecacatan tanpa melemahkan kegunaan bahagian.*

C. *Menentukan kecacatan yang boleh diterima dari yang tidak boleh diterima.*

D. *Semua di atas adalah diaplikasikan.*

12. *Kutub Utara dan Selatan bagi magnet akan:*

A. *Menolak antara satu sama lain.*

B. *Menarik ke arah satu sama lain.*

C. *Menarik atau menolak bergantung kepada orientasi domain.*

D. *Menghasilkan fluk kapasitan.*

13. *Yang manakah jenis bahan yang mempunyai sedikit kesan penolakan apabila medan magnetik dikenakan?*

A. *Bahan Diamagnetik.*

B. *Bahan Paramagnetik.*

C. *Bahan Ferromagnetik.*

D. *Bahan Sterromagnetik.*

14. *Suatu retakan akan menggangu garisan daya dengan menghasilkan:*

A. *Bocoran fluk.*

B. *Daya paksaan.*

C. *Fluk magnetik.*

D. *Daya resistif.*

15. *Kemudahan bagi bahan untuk dimagnetkan dipanggil:*

A. *Kebolehtelapan.*

B. *Relaktan.*

C. *Kemagnetan bakian.*

D. *Ketersimpanan.*

16. *Keluli berkarbon tinggi yang dimagnetkan mempunyai:*

A. *Permeabiliti/ Kebolehtelapan tinggi.*

B. *Relaktan rendah.*

C. *Pemagnetan bakian rendah.*

D. *Daya paksaan tinggi.*

17. *Keluli berkarbon rendah yang dimagnetkan mempunyai:*

A. *Permeabiliti/Kebolehtelapan tinggi.*

B. *Relaktan tinggi.*

C. *Pemagnetan bakian tinggi.*

D. *Daya paksaan tinggi.*

18. *Medan magnetik membulat boleh diaruhkan kepada komponen dengan:*

A. *Pengaruhan terus.*

B. *Pengaruhan pusat.*

C. *Pengaruhan terbalik.*

D. *Pengaruhan bakian.*

19. *Apakah arah daya garisan magnetik dalam perhubungan dengan arah arus?*

A. *25 darjah.*

B. *45 darjah.*

C. *90 darjah.*

D. *100 darjah.*

20. *Yang mana daripada berikut menghasilkan medan magnetik membulat?*

A. *Penduga kontor.*

B. *Lingkaran.*

C. *Penduga-penduga.*

D. *Semua di atas.*

21. *Aplikasi bahan penusuk yang biasa adalah dengan:*

A. *Rendaman.*

B. *Semburan.*

C. *Sapuan.*

D. *Hanya A dan B.*

27. *Kebolehan pembasahan adalah:*

A. *Kebolehan bahan penusuk untuk melitupi permukaan bahagian.*

B. *Kebolehan cecair untuk memasuki kecacatan.*

C. *Kebolehan untuk memegang molekul di permukaan bersama-sama.*

D. *Lekatan yang diperlukan untuk memegang bahan penusuk pada tempatnya.*

28. *Bahan penusuk pelarut boleh-buang memerlukan:*

A. *Satu pengemulsi.*

B. *Pelarut dikenakan pada kain tiras bersih dan dilap atas permukaan komponen.*

C. *Semburan air untuk membuang bahan penusuk lebihan daripada permukaan komponen.*

D. *Kesemua di atas mungkin boleh digunakan.*

29. *Manakah jenis pengemulsi yang berfungsi dengan melarutkan bahan penusuk yang berlebihan dan menjadikannya boleh-cuci air?*

A. *Pengemulsi hidrofilik.*

B. *Pengemulsi lipofilik.*

C. *Pengemulsi pembuang pelarut.*

D. *Pengemulsi akues.*

30. *Suhu minimum pada mana cecair menyala dipanggil:*

A. *Titik nyalaan.*

B. *Titik kilatan.*

C. *Titik pengewapan.*

D. *Titik api.*

31. *Apakah jenis bahan kimia yang digunakan untuk membuat bahan penusuk boleh-cuci air?*

A. *Pengemulsi.*

B. *Kimia organik.*

C. *Hidrofilik.*

D. *Pelarut.*

32. *Kaedah pengeringan yang paling cekap dari segi kos untuk mengeringkan komponen adalah:*

A. Pengering udara panas.

B. Pengering udara pegangan-tangan.

C. Kipas.

D. Pengering rambut.

(70 markah)

From 33 to 47; State whether the following statements true or false.

(33) The investigator dose not care to record pertinent features on failed components.

(34) It is recommended to re-mate the fracture surfaces to see if they fit together.

(35) A common procedure is to spray the fracture surface with a clear enamel or acrylic to create artifacts that would confuse or inhibit fracture interpretation.

(36) Moisture created from the cleaning process or humidity can greatly affect the ability of the penetrant to float onto the surface of the component and produce capillary action.

(37) Cleaning a component is performed in order to remove any contaminants that may compromise the inspection process.

(38) Inorganic contaminants are materials such as rust, dirt, mineral deposits, plastic, and salt.

(39) Alkaline cleaners are detergents that remove certain types of organic contaminants. These include most oil based contaminants.

(40) It is important that the cleaning process should slightly etch the part.

(41) The minimum penetrant dwell time is based on the established procedures.

(42) If the part under inspection is too large for the penetrant tank, the spraying method can be used.

(43) A component may need to be rotated or re-dipped in order for the part to have complete coverage.

(44) Hotter components require a longer dwell time.

(45) Once the penetrant has completely entered a discontinuity, a longer dwell time will not improve the results.

(46) Emulsification times will vary from fifteen seconds to 5 minutes depending on the type of emulsifier.

(47) The acoustic impedance, Z, of a material is defined as the product of density, r, and acoustic velocity, V, of that material.

(30 marks)

Daripada 33 hingga 47, nyatakan samada kenyataan berikut adalah BENAR ataupun SALAH.

(33) Pemeriksa tidak mengambil peduli untuk merekod ciri-ciri berkaitan dalam komponen-komponen yang gagal.

(34) Adalah disyorkan untuk memadan-semula permukaan patah untuk melihat jika ianya sama sepadan.

(35) Suatu prosedur biasa untuk menyembur permukaan patah dengan enamel jernih ataupun akrilik untuk menghasilkan artifak yang boleh mengelirukan ataupun merencat intepretasi patah.

(36) Lembapan yang terjadi daripada proses pencucian ataupun humiditi boleh memberi kesan yang besar terhadap kebolehan bahan penusuk untuk terapung di permukaan komponen dan menghasilkan tindakan kapilari.

(37) Pembersihan komponen dilaksanakan dalam usaha untuk mengeluarkan mana-mana bahan cemar yang boleh menjejaskan proses pemeriksaan.

(38) Bahan cemar tak-organik adalah bahan seperti karat, kotoran, enapan mineral, plastik dan garam.

(39) Pembersih-pembersih alkali adalah pembersih yang mengeluarkan jenis-jenis bahan cemar organik tertentu. Ini termasuklah kebanyakan bahan cemar berasaskan minyak.

(40) Adalah penting proses pencucian sepatutnya memunar sedikit bahagian yang hendak diperiksa.

(41) Masa enap minimum bahan penusuk adalah berdasarkan kepada prosedur-prosedur yang ditetapkan.

(42) Sekiranya bahagian untuk pemeriksaan adalah terlalu besar untuk tangki bahan penusuk, kaedah penyemburan boleh digunakan.

(43) Sesuatu komponen mungkin perlu dipusingkan ataupun dicelup-semula untuk memastikan liputan yang sempurna.

(44) Komponen yang lebih panas memerlukan masa enap yang lebih lama.

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SECTION B

BAHAGIAN B

2. [a] (i) In any failure analysis, it is important to get as much information as possible from the failed part itself along with an investigation of the conditions at the time of failure. There are some questions to be asked. State these questions?

(ii) State the importance of visual inspection?

(iii) What is the basic procedure for examination of fractures?

(iv) What is the usual sequence of operations in the examination of fractured components?

(60 marks)

[b] State the advantages and disadvantages of each of the following:

(i) Non-aqueous wet developer

(ii) Water suspendable developer

(40 marks)

2. *[a] (i) Dalam mana-mana analisis kegagalan, adalah amat penting untuk memperolehi sebanyak maklumat yang mungkin daripada bahagian yang gagal tersebut, bersama-sama dengan penyiasatan keadaaan semasa kegagalan. Terdapat beberapa pertanyaan ataupun soalan-soalan yang sepatutnya ditanyakan. Nyatakan soalan-soalan ini.*

(ii) Nyatakan kepentingan pemeriksaan visual.

(iii) Apakah prosedur asas untuk pemeriksaan kepatahan?

(iv) Apakah langkah-langkah biasa dalam pengoperasian pemeriksaan komponen-komponen patah?

(60 markah)

[b] Nyatakan kebaikan dan kelemahan bagi setiap yang berikut:

(i) Pembangun basah tak-akues.

(ii) Pembangun boleh-ampaian air.

(40 markah)

3. [a] (i) How does capillary action works in penetrant testing? Explain with the aid of diagrams and take the requirements of a penetrant and surface contamination in consideration.

(ii) Explain the characteristics of piezoelectric transducers with the aid of diagrams.

(iii) Define Fresnel and Fraunhofer Effects.

(40 marks)

[b] In ultrasonic testing calculate the following:

(1) Calculate the surface distance when a Transducer angled with 60° on a part thickness of 60mm.

(2) Calculate the depth of the defect when a Transducer angled with 45° and sound path measured is 13 (mm).

(3) The near field (Fresnel zone) for ultrasonic wave velocity of 0.585 x10° cm/sec in a steel at frequency of 1.0MHZ and transducer size of 12mm.

(60 marks)

3. [a] (i) Bagaimanakah tindakan kapilari berlaku dalam pengujian penusukan? Terangkan dengan bantuan rajah-rajah dan mengambilkira keperluan bahan penusuk dan pencemar permukaan.

(ii) Terangkan sifat-sifat transduser Piezo-elektrik dengan bantuan gambarajah.

(iii) Takrifkan Kesan Fresnel dan Fraunhofer.

(40 markah)

[b] Dalam ujian ultrasonik, kirakan yang berikut:

(1) Kirakan jarak permukaan apabila transduser bersudut 60° pada bahagian berketebalan 60 mm.

(2) Kirakan kedalaman kecacatan dengan transduser bersudut 45° dan laluan bunyi dikirakan adalah 13 (mm).

(3) Medan dekat (zon Fresnel) untuk halaju gelombang ultrasonik adalah 0.585 x10° cm/saat dalam keluli pada frekuensi 1.0 MHz dan transduser bersaiz 12 mm.

(60 markah)

5. [a] Explain the concept of Magnetic Particle Inspection (MPI) and where applicable, your description must be accompanied with appropriate sketches.

(60 marks)

[b] What are the advantages and disadvantages of Magnetic Particle Testing method?

(20 marks)

[c] Explain two types of method for magnetism induction for MPI.

(20 marks)

5. *[a] Terangkan konsep Pemeriksaan Partikel Magnetik (PPM) dan di mana berpatutan penerangan anda hendaklah berserta dengan lakaran yang berseuaian*

(60 markah)

[b] Apakah kebaikan dan keburukan kaedah pengujian partikel magnetik.

(20 markah)

[c] Terangkan dua jenis kaedah pengaruhan pemagneran bagi PPM.

(20 markah)

7. [a] Calculate the Length of First Leg (1/2 V path) for probe with transducer angle 60° and material thickness of 63.5mm. Repeat calculation of Full V-path for probe with transducer angle 45° and material thickness of 63.5mm.

(30 marks)

[b] Explain two types of sound wave used in Ultrasonic Testing and how did they were generated.

(30 marks)

[c] How to measure crack tip measurement by Ultrasonic Testing methods.

(40 marks)

7. *[a] Kirakan "Panjang bagi Kaki Pertama" (laluan 1/2 V) untuk kuar dengan sudut transduser 60° dan bahan bertebalan 63.5mm. Ulang pengiraan untuk "Laluan V Penuh" untuk kuar bersudut 45° dan bahan bertebalan 63.5 mm.*

(30 markah)

[b] Terangkan dua jenis gelombang bunyi yang digunakan dalam Pengujian Ultrasonik dan bagaimana ianya dijanakan.

(30 markah)

[c] Bagaimana untuk mengukur 'tip retakan' dengan kaedah Pengujian Ultrasonik.

(40 markah)

LAMPIRAN
APPENDIX

UNIVERSITI SAINS MALAYSIA
PEPERIKSAAN SEMESTER I, SIDANG AKADEMIK 2004/2005

EBB 405E/3 - Failure Analysis and Non-Destructive Testing
(Penyiasatan Kegagalan dan Ujian Tak Musnah)

Angka Giliran : _____

Angka Giliran Dalam Perkataan : _____

ANSWER SHEET FOR SECTION A/KERTAS JAWAPAN BAHAGIAN A,
(Attention : Attach to your answer booklet)

1.	=A=	=B=	=C=	=D=	17.	=A=	=B=	=C=	=D=
2.	=A=	=B=	=C=	=D=	18.	=A=	=B=	=C=	=D=
3.	=A=	=B=	=C=	=D=	19.	=A=	=B=	=C=	=D=
4.	=A=	=B=	=C=	=D=	20.	=A=	=B=	=C=	=D=
5.	=A=	=B=	=C=	=D=	21.	=A=	=B=	=C=	=D=
6.	=A=	=B=	=C=	=D=	22.	=A=	=B=	=C=	=D=
7.	=A=	=B=	=C=	=D=	23.	=A=	=B=	=C=	=D=
8.	=A=	=B=	=C=	=D=	24.	=A=	=B=	=C=	=D=
9.	=A=	=B=	=C=	=D=	25.	=A=	=B=	=C=	=D=
10.	=A=	=B=	=C=	=D=	26.	=A=	=B=	=C=	=D=
11.	=A=	=B=	=C=	=D=	27.	=A=	=B=	=C=	=D=
12.	=A=	=B=	=C=	=D=	28.	=A=	=B=	=C=	=D=
13.	=A=	=B=	=C=	=D=	29.	=A=	=B=	=C=	=D=
14.	=A=	=B=	=C=	=D=	30.	=A=	=B=	=C=	=D=
15.	=A=	=B=	=C=	=D=	31.	=A=	=B=	=C=	=D=
16.	=A=	=B=	=C=	=D=	32.	=A=	=B=	=C=	=D=