UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

Second Semester Examination
2002/2003 Academic Session

Februari/Mac 2003

February/March 2003

ESA 224/3 – Pemesinan dan Pemprosesan Bahan

(Machining And Materials Processing)

Masa : [3 Jam]

Time : [3 hours]

ARAHAN KEPADA CALON :

INSTRUCTION TO CANDIDATES:

1. Sila pastikan bahawa kertas peperiksaan ini mengandungi **(21) DUA PULUH SATU** mukasurat bercetak termasuk lampiran dan **(7) TUJUH** soalan.
   *Please ensure that this paper contains **(21) TWENTY ONE** printed pages including attachments and **(7) SEVEN** questions.*

2. Anda dikehendaki menjawab **SEMUA** soalan di Bahagian A iaitu 1(a) dan 1(b) dan **(4) EMPAT** soalan di Bahagian B.
   *Please answer **ALL** the questions from section A that is 1(a) and 1(b) and **(4) FOUR** questions from section B*

3. Agihan markah bagi setiap soalan diberikan di sut sebelah kanan.
   The marks allocated for each question is shown on the right hand side.

4. Jawab semua soalan dalam Bahasa Melayu **kecuali soalan nombor 2 dan 3 perlu dijawab dalam Bahasa Inggeris. Bahagian A mestilah dijawab dalam kertas jawapan khas yang disediakan dan diikat bersama buku jawapan.**
   Answer all the questions in Bahasa Melayu except question no.2 and 3 should be answered in English . Section A must be answered in the special answer paper and tied up with answer booklet.

5. Mesin kira bukan yang boleh diprogram boleh digunakan.
   Non programmable calculator can be used.

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Bahagian A/Part A

Hitamkan jawapan di kertas jawapan khas yang disediakan.

Shade/Bold the appropriate answer in the special answer paper.

1. (a) (i) Keluli tahan karat dielakkan dari karatan akibat campuran dengan

(a) Kromium
(b) Karbon
(c) Silika
(d) Plumbum

Stainless Steels are protected from corrosion due to the presence of:

(a) Chromium
(b) Carbon
(c) Silica
(d) Lead

(ii) Keluli yang digunakan pada struktur aeroangkasa mengandungi kromium dan

(a) Tin
(b) Nikel
(c) Grafit
(d) Plumbum

The steels used in aircraft aerospace structure contain Chromium and

(a) Tin
(b) Nickel
(c) Graphite
(d) Lead

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(iii) Fasa di mana cecair dan pepejal dinamakan

(a) Kawasan Austenit
(b) Pemejalan
(c) Percampuran (mushy)
(d) Pembekuan

The phase at which both liquid and solid is called as:

(a) Austenic Area
(b) Solidification
(c) Mushy
(d) Freezing

(iv) Zon teturus membesar di atas

(a) Zon cecair
(b) Dendrit
(c) Mikrostruktur
(d) Zon dingin

The Columnar Zone grows above the:

(a) Liquid Zone
(b) Dendrite
(c) Microstructure
(d) Chill Zone

(v) Retak mudah terjadi dalam proses penuangan semasa pemejalan dinamakan:

(a) Pengoyakan panas
(b) Retak pepejal
(c) Cacat
(d) Permukaan kasar

The tendency to crack in the casting during solidification is called as:

(a) Hot tearing
(b) Solid crack
(c) Flaws
(d) Rough surface

(vi) Alat untuk mengukur kekasaran permukaan dipanggil

(a) Pengindeks permukaan
(b) Metersusuk permukaan
(c) Takometer
(d) Penstabil

The instrument used to measure the surface roughness is known as:

(a) Surface Indexer
(b) Surface Profilometers
(c) Tachometer
(d) Stabiliser

(vii) Kecacatan permukaan akibat pertindihan bahan ketika proses dinamakan

(a) Lubang
(b) Lipatan
(c) Kelim
(d) Benteng

Surface defects due to overlapping of the material during processing is called as:

(a) Pits
(b) Folds
(c) Seams
(d) Lays

(viii) Perbezaan terkecil dalam dimensi yang sesuatu alat mampu mengesan dipanggil

(a) Kejituan
(b) Perbezaan
(c) Sisihan
(d) Kepekaan

The smallest difference in dimensions that an instrument can detect is called as:

(a) Accuracy
(b) Difference
(c) Deviation
(d) Sensitivity

(ix) Alat yang digunakan untuk mengukur aci atau bahagian yang bulat dipanggil

(a) Tolok gelang
(b) Angkup vernier
(c) Tolok palam
(d) Bar sin

The gage which is used measure the shafts or round parts is called as:

(a) Ring gauge
(b) Vernier calipers
(c) Plug Gage
(d) Sine bar

(x) Nisbah keluaran alatan terhadap dimensi masukan dipanggil

(a) Ketelurusan
(b) Pembesaran
(c) Penstabilan
(d) Pendaratan

The ratio of instrument output to the input dimension is called as:

(a) Linearity
(b) Magnification
(c) Stability
(d) Multiplication

(50 markah/*marks*)

Tuliskan jawapan yang sesuai di Kertas Jawapan Khas yang disediakan.

Write the correct answer in the special answer paper provided.

1. (b) (i) Besi jongkong dibuat dari galian menggunakan relau _____.
(Relau Bagas/Relau Muffle)

Pig iron is produced from the ores using the furnace _____.
(Blast Furnace/Muffle Furnace)

(ii) Lubang-lubang berbentuk sfera besar berhampiran permukaan jongkong semasa pembuatan keluli dipanggil _____. (Cacatan/Lubang Hembus)

The large spherical holes near the surface of the ingots in Steel making is called as _____. *(Flaws/Blow Holes)*

(iii) Proses pembersihan bendasing pada aloi ferus dipanggil _____. (Penapisan/Pembentukan)

The process of removal of impurities in ferrous alloys is called as _____. *(Refining/Forming)*

(iv) Keluli yang mengandungi kromium yang tinggi sehingga 27% dipanggil _____. (Tahan Karat/Berferit)

Steel containing high Chromium content up to 27% are called as _____. *(Stainless/Ferritic – 400 series)*

(v) Keluli dua fasa menambahbaik sifat pembentukan dan _____. (Kemuluran/Kelembutan)

The Dual Phase Steels improve the properties of formability and _____. *(Ductility/Softness).*

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(vi) Kedalaman dan sifat lapisan pengerasan kerja dipanggil _____. (Kekasaran/Struktur Permukaan)

The depth and properties of the work hardened layer is called as _____. (Roughness/Surface Structure)

(vii) Dalam pengukuran kekasaran, ketinggian maksima dari puncak ke paluh yang terdalam dicatat sebagai _____. (R_t/R_q)

In Roughness measurement, the maximum height of the peak to the deepest trough is denoted as _____. (R_t/R_q)

(viii) Sisihan kecil kesudutan pada permukaan rata diukur dengan jitu menggunakan _____. (Bar Sin/Meterautocolli)

Small angular deviations on flat surface is accurately measured using _____. (Sinebar/Autocollimeter)

(ix) Teknik pengukuran keratan menggunakan rataan optik dipanggil _____. (Meteran Gangguan/Metalografi)

The measurement technique of flatness using optical flats is known as _____. (Interferometry/Metexllography)

(x) Bar sin selalu digunakan untuk mengukur _____. (Integriti Permukaan/Sudut)

Sine bar is normally used to measure _____. (Surface Integrity/Angles)

(50 markah/*marks*)

Bahagian B/Part B

Jawab (4) EMPAT soalan dari (6) ENAM soalan

Answer any (4) FOUR questions from (6) SIX questions

2. (a) Terangkan kaedah kerja relau induksi dalam pembuatan keluli

(b) Lakarkan sebarang (2) dua struktur tuangan logam ketika pemejalan dalam acuan

(c) Tunjukkan sebarang (4) empat kecacatan dalam penuangan.

(a) Explain the working of Induction Furnace in the production of steel.

(40 markah/*marks*)

(b) Sketch any two cast structures of metals being solidified in a mold.

(40 markah/*marks*)

(c) *Show any four casting defects.*

(20 markah/*marks*)

3. (a) Lakarkan dan tunjukkan acuan pasir bersama bahagiannya disertai "Cope over the Drag".

(b) Tunjukkan terminologi dan simbol-simbol piawai untuk menerangkan kemasan permukaan.

(c) Lakarkan dan tunjukkan kaedah penggunaan sebarang 2 tolok yang digunakan dalam metrologi.

(a) Sketch and show the Sand mold with its parts with the Cope over the Drag.

(40 markah/*marks*)

(b) Show the Standard Terminology and symbols to describe surface finish.

(40 markah/*marks*)

(c) Sketch and show the working of any two gages used in Metrology.

(20 markah/*marks*)

4. (a) Adakah digalakkan menambahkan kelajuan pemotongan untuk tujuan menambah kadar pengeluaran? Berikan dua sebab.

(b) Persamaan jangka hayat alat pemotong atau lebih dikenali sebagai Persamaan Taylor menghubungkan kelajuan pemotongan (v) dan jangka hayat alat pemotong (T) bersama dengan parameter n (bergantung kepada bahan alat pemotong) dan C (bergantung kepada bahan kerja dan keadaan pemotongan). Persamaan Taylor ialah $vT^n = C$. Dalam satu proses pelarikan tanpa bantuan cecair penyejuk, v = 80 m/min, n = 0.130 dan C = 120 m/min. Apabila cecair penyejuk digunakan, adakah C akan berkurang atau bertambah? Jika perubahan kepada C adalah sebanyak 11% setelah penggunaan cecair penyejuk, kirakan peratus perubahan jangka hayat alat pemotong, jika v tidak berubah.

(c) Dalam suatu proses pengisaran permukaan (face milling) terhadap satu bahankerja keluli yang berukuran 12 sm X 2 sm, telah digunakan sebuah pengisar yang bergarispusat 4 sm yang mempunyai 5 gigi. Kelajuan pemotongan (nota: bukan kelajuan bahan kerja) ialah 600sm/min, kadar hantaran atau suapannya ialah 0.01 sm/gigi dan kedalaman pemotongannya ialah 0.10 sm. Carikan jangkamasa pemotongan permukaan bahankerja dan kadar penyerpihan bahannya.

(a) Is it recommended to increase the speed of cutting in order to increase the rate of output? Give two reasons.

(20 markah/*marks*)

(b) Lifetime equation of a cutter or known as Taylor's equation relates cutting speed (v) and lifetime of cutter (T) along with parameter n (depending on cutter material) and C (depending on workpiece and cutting conditions). Taylor equation is $vT^n = C$. *In a cutting process using a lathe machine without cooling fluid, v = 80 m/min, n = 0.130 and C = 120 m/min. When cooling fluid is used, does C increases or decreases? If the changes in C is 11% as a result of applying cooling fluid, calculate the change percentage in lifetime of the cutter if v remains constant.*

(40 markah/*marks*)

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(c) *In a face milling process on a steel workpiece with dimension of 12 cm x 12 cm, a milling tool of 4 cm diameter with 5 teeth was used. Cutting speed (note: this is not speed of workpiece) is 600 cm/min, feed rate is 0.01 cm/teeth, and cutting depth is 0.10 cm. Determine time needed for cutting the face of workpiece and rate of removal.*

(40 markah/*marks*)

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5. (a) Secara ringkas, berikan empat keperluan (dari aspek teknikal sahaja) yang menyebabkan operasi pemesinan lebih diutamakan daripada operasi-operasi pembuatan yang lain.

(b) Daripada pelbagai jenis pemotongan tak tradisi, yang manakah akan menghasilkan kerosakan "thermal"? (Nota: Jawapan yang salah akan dikenakan penalti)

(c) Dalam satu proses pemesinan secara kimia terhadap satu keping keluli berketebalan 1.5 sm dan rata, sebuah poket bulat yang berkedalaman 0.5 sm dan bergarispusat 16.5 sm akan dihasilkan. Satu larutan asid hidroklorik dan nitrik digunakan sebagai penghakis atau punar (etchant). Diberikan kadar penusukan untuk keluli itu adalah 0.002 sm/min.

(i) Tentukan kadar produktiviti proses. Berikan andaian yang dibuat.
(ii) Tempoh pemesinan.

(d) Mengapakah sifat mekanikal bahan kerja tidak relevan dalam pemesinan tak tradisi? Berikan satu alasan dan contohnya.

(a) Briefly, state four or needs (related to technical aspects) that made machining operation is preferable compared to other manufacturing processes.

(20 markah/*marks*)

(b) Among various non-traditional cutting processes, which are the ones that result in thermal damage? (Note: wrong answer will be penalized).

(20 markah/*marks*)

(c) *In a chemical machining process on a piece of flat steel with thickness of 1.5 cm, a round pocket with 0.5 cm depth and diameter of 16.5 cm will be produced. Hydrochloric and nitric acid solution is used as etchant. Given is rate of penetration for steel at 0.002 cm/min. Determine:*

(i) *process production rate. State any assumptions made.*
(ii) *machining period.*

(40 markah/*marks*)

(d) *Why does the mechanical property of workpiece is not relevant in a non-conventional machining? State <u>one</u> reason an example.*

(20 markah/*marks*)

6. (i) Pengisar pengelekan yang mempunyai dua penggelek telah disuap dengan satu jalur berukuran 300 mm lebar dan 30 mm tebal. Jejari penggelek berukuran 300 mm. Ketebalan bahan kerja hendak dikurangkan kepada 26 mm dalam satu suapan pada kelajuan gelekan 50 rpm. Bahan kerja ialah keluli karbon tinggi dan telah disepuhlindap dan pekali geseran di antar penggelek dan bahan kerja diandaikan 0.125.

(a) adakah pekali geseran mencukupi untuk operasi penggelekan dijalankan?

Jika ya, Kira:

(b) daya gelekan (dalam N)

(c) tork (dalam N-m) dan

(d) kuasa (dalam hp)

(i) Rolling mill with two powered rollers is fed with a 300 mm wide strip of 30 mm thick. The rollers are of radius = 300 mm. The thickness of the workpiece is to be reduced to 26 mm in one pass at a roll speed of 50 rpm. The material of the workpiece is Annealed High Carbon Steel, and the coefficient of friction between rollers and the work piece is assumed = 0.125

(a) Is the friction between the rolls sufficient to permit the rolling operation to be accomplished?

If so, calculate:

(b) the roll force (in N),

(c) the torque (in N-m), and

(d) the power (in hp)

(40 markah/*marks*)

(ii) Satu bahan kerja berbentuk silinder akan menjalani operasi penempaan sejuk. Ukuran bahan kerja adalah 50 mm tinggi dan 60 mm garispusat. Ketinggian bahan kerja hendak dikurangkan kepada 40 mm. Bahan kerja ialah kuprum tulen yang telah disepuhlindap. Andaikan pekali geseran $\mu = 0.1$.

(a) kira daya semasa proses bermula (dalam N)

(b) kira daya pada ketinggian 42 mm (dalam N)

(ii) A cylindrical workpiece is subjected to a cold forging operation. The input workpiece is 50 mm in height and 60 mm in diameter. The workpiece is to be reduce to a height of 40 mm. The work material is Annealed Pure Copper. Assume a coefficient of friction $\mu = 0.1$.

(a) Calculate the force as the process begins (in N)

(b) Calculate the force at height of 42 mm (in N)

(30 markah/*marks*)

(iii) Satu bilet berukuran 400 mm panjang dan 100 mm garispusat akan disemprit dalam satu operasi penyempritan terus dengan nisbah penyempritan $r_x = 4.0$. Keratan rentas penyemprit berbentuk bulat. Sudut acuan (sudut separuh) = 90^0. Bahan kerja ialah aloi kuprum (loyang).

(a) anggarkan terikan penyempritan (dalam MPa) (gunakan formula Johnson dengan a = 0.8 dan b = 1.5)

(b) Tentukan tekanan (dalam MPa) yang dialami oleh bilet semasa lejang pelantuk L = 125 mm.

(iii) A billet 400 mm long and 100 mm in diameter is to be extruded in a direct extrusion operation with extrusion ratio $r_x = 4.0$.
The extrudate has a round cross section. The die angle (half-angle) = 90^0. The work metal is Copper alloy (Brass).

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(a) Estimate the extrusion strain (in MPa) (use Johnson formula with a = 0.8 and b = 1.5).

(b) Determine the pressure applied to the billet when the ram stroke L = 125 mm (in MPa).

(30 markah/*marks*)

7. (i) Satu cakera berbentuk bulat 120 mm diameter hendak dipadam dari satu jalur berukuran 3 mm sesetengah keras keluli yang digelek sejuk berkekuatan ricih = 310 MPa.

(a) Kira garis pusat yang sesuai untuk tebuk dan acuan (dalam mm)

(b) Kira daya padaman (dalam N)

(i) A round disk of 120 mm diameter is to be blanked from a strip of 3 mm half hard cold-rolled steel whose shear strength = 310 MPa.

(a) Calculate the appropriate punch and die diameters (in mm)

(b) Calculate the blanking force (in N)

(20 markah/*marks*)

(ii) Satu operasi penarikan digunakan untuk membuat cawan berbentuk silinder dengan garis pusat dalaman = 60 mm dan ketinggian = 50 mm. Ukuran permulaan padam = 120 mm dan ketebalan stok = 2 mm

(a) adakah proses ini mampu dijalankan?

Jika ya, diberi kekuatan tegangan untuk kepingan keluli karbon rendah = 320 MPa, kekuatan alah = 180 MPa, jejari penjuru acuan = 5 mm.

(b) daya penarikan (dalam N) dan

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(c) daya pegangan diperlukan untuk menjalankan operasi ini (dalam N)

(ii) *A drawing operation is used to from a cylindrical cup with inside diameter = 60 mm and height = 50 mm. The starting blank size = 120 mm and the stock thickness = 2 mm.*

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(a) is the process feasible?

If so, given that the tensile strength of the low carbon steel sheet metal = 320 MPa, and yield strength = 180 MPa, the die corner radius = 5 mm,

(b) calculate the drawing force (in N), and

(c) Holding force required to perform the operation (in N)

(30 markah/*marks*)

(iii) Operasi kimpalan arka tungsten gas dijalankan pada arus 320 A dan voltan 20 V. Kecekapan peleburan $f_2 = 0.5$ dan unit tenaga peleburan untuk logam $U_m = 10$ J/mm^3. Kira:

(a) keperluan kuasa untuk operasi ini (dalam Watt)

(b) kadar penjanaan haba pada kimpalan (dalam J/s)

(c) kadar isipadu logam dikimpal (dalam mm^3/s)

(iii) *A gas tungsten AW operation is performed at a current of 320 A and voltage of 20 V. The melting efficiency f_2 = 0.5, and the unit melting energy for the metal U_m = 10 J/mm^3.*

(a) determine the power required in the operation (in Watt)

(b) rate of heat generation at the weld (in J/s), and

(c) volume rate of metal welded (in mm^3/s)

(30 markah/*marks*)

(iv) Operasi kimpalan rintangan bintik dijalankan pada 2 kepingan keluli 1.5 mm tebal menggunakan 12500 A dalam waktu 0.20 saat. Garis pusat elektrod di permukaan sentuh ialah 6 mm. Andaikan rintangan ialah 0.0001 ohms dan nugget kimpal yang dihasilkan ialah 5 mm garis pusat dan 2.4 mm tebal. Unit tenaga peleburan untuk logam U_m = 12 J/mm^3.

(a) keperluan haba untuk meleburkan nugget kimpal (dalam J)

(b) jumlah haba yang diserap kepada logam sekeliling (dalam J)

(iv) *A resistance spot welding operation is performed on two pieces of 1.5 mm thick steel using 12,500 A for a 0.20 second duration. The electrodes are 6 mm in diameter at the contacting surfaces. Resistance is assumed to be 0.0001 ohms, and the resulting weld nugget is 5 mm in diameter and 2.4 mm thick. The unit melting energy for the metal U_m = 12.0 J/mm^3.*

(a) Calculate the amount of heat required to melt the weld nugget (in J)

(a) Calculate the amount of the heat absorbed into the surrounding metal (in J)

(20 markah/*marks*)

Lampiran 1/*Appendix 1*

Table answer no.6 (i)

Typical values of strength coefficient K and strain hardening exponent n for selected metals.

Material	Strength Coefficient, K	Strain Hardening Exponent, n
Aluminum, pure, annealed	175	0.20
Aluminum alloy, annealed	240	0.15
Aluminum alloy, heat treated	400	0.10
Copper, pure, annealed	300	0.50
Copper alloy : Brass	700	0.35
Steel , low C, annealed	500	0.25
Steel, high C, annealed	850	0.15
Steel alloy, annealed	700	0.15
Steel, stainless, austenitic, annealed	1200	0.40

Table answer no. 7 (i)

Allowance value a for three sheet metal groups

Metal Group	a
1100S and 5052S aluminum alloys, all tempers.	0.045
2024ST and 6061ST aluminum alloys; bass, all tempers; soft cold rolled steel, soft stainless steel.	0.060
Cold rolled steel, half hard, stainless steel, half hard and full hard.	0.075

Table answer no. 7 (iii)

Heat Transfer efficiencies for several arc-welding processes.

Arc Welding Process	Typical Heat Transfer Efficiency f_1
Shielded metal arc welding	0.9
Gas metal arc welding	0.9
Flux-cored arc welding	0.9
Submerged arc welding	0.95
Gas tungsten arc welding	0.70

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Lampiran 2/*Appendix 2*

Kertas Jawapan ESA 224/3/*Answer Paper ESA 224/3*

Arahan : **Hitamkan jawapan yang sesuai**
Instruction : ***Shade/bold the appropriate answer***

1.	**(a)**	(i)	= A =	= B =	= C =	= D =
		(ii)	= A =	= B =	= C =	= D =
		(iii)	= A =	= B =	= C =	= D =
		(iv)	= A =	= B =	= C =	= D =
		(v)	= A =	= B =	= C =	= D =
		(vi)	= A =	= B =	= C =	= D =
		(vii)	= A =	= B =	= C =	= D =
		(viii)	= A =	= B =	= C =	= D =
		(ix)	= A =	= B =	= C =	= D =
		(x)	= A =	= B =	= C =	= D =

1. **(b)** (i) _____

(ii) _____

(iii) _____

(iv) _____

(v) _____

(vi) _____

(vii) _____

(viii) _____

(ix) _____

(x) _____

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