
UNIVERSITI SAINS MALAYSIA

**Second Semester Examination
Academic Session 2008/2009**

*Peperiksaan Semester Kedua
Sidang Akademik 2008/2009*

APRIL/MAY 2009

**EPP 222/3 – ADVANCED MANUFACTURING TECHNOLOGY
TEKNOLOGI PEMBUATAN TERMAJU**

**Duration : 3 hours
Masa : 3 jam**

INSTRUCTIONS TO CANDIDATE :
ARAHAN KEPADA CALON :

Please check that this paper contains **NINE** (9) printed pages and **SIX** (6) questions before you begin answering the questions.

*Sila pastikan bahawa kertas soalan ini mengandungi **SEMBILAN** (9) mukasurat dan **ENAM** (6) soalan yang bercetak sebelum anda mula menjawab soalan.*

Answer **FIVE** (5) questions only.

*Sila jawab **LIMA** (5) soalan sahaja.*

Answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.

*Calon boleh menjawab semua soalan dalam **Bahasa Inggeris** ATAU **Bahasa Malaysia** ATAU kombinasi kedua-duanya.*

Answer to each question must begin from a new page.

Jawapan bagi setiap soalan mestilah dimulakan pada mukasurat yang baru.

- Q1. [a] Describe briefly **THREE (3)** general factors that need to be considered in the selection of the machining center so that it is an economical investment.

Huraikan secara ringkas TIGA (3) faktor umum yang perlu dipertimbangkan untuk membuat pemilihan pemesinan sepusat supaya ianya adalah satu pelaburan yang ekonomik.

(20 marks/markah)

- [b] Discuss briefly how would you go about reducing the total machining cost in order to meet the level of economics in machining by referring to the following Figure Q1[b].

Bincangkan secara ringkas bagaimanakah cara anda mengurangkan jumlah kos pemesinan bagi mencapai tahap pemesinan yang ekonomik dengan merujuk Rajah S1[b].

(40 marks/markah)

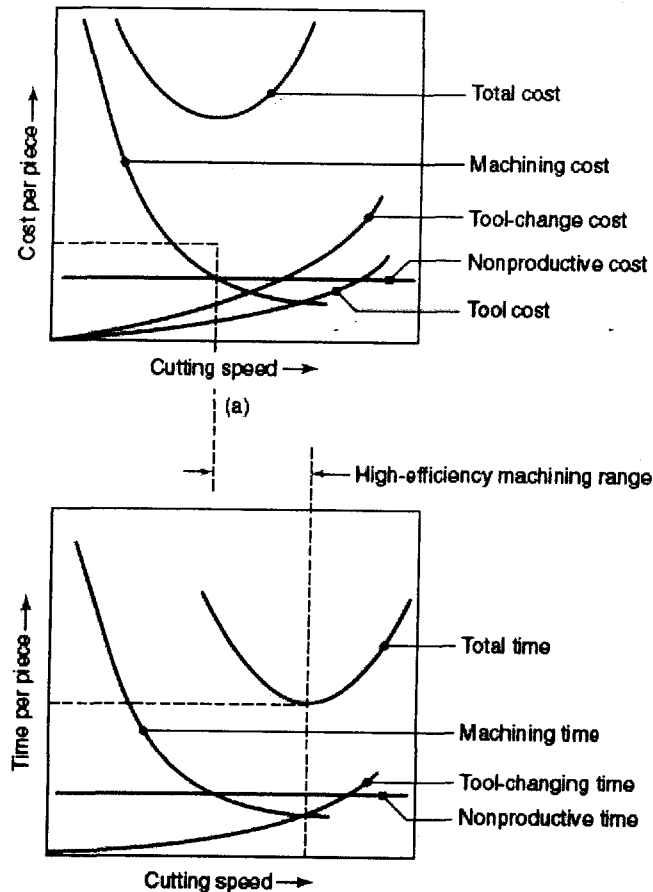


Figure Q1[b] – Machining Economics
Rajah S4[b] – Ekonomik Pemesinan

- [c] **There are TWO (2) main factors that involve in producing a component which are; proper selection of materials and suitable manufacturing processes.**

Terdapat DUA (2) faktor utama yang melibatkan penghasilan satu komponen iaitu; pemilihan bahan dan proses pembuatan yang sesuai.

- (i) **As a manufacturer give your justification, which of the two factors mentioned above is more important.**

Sebagai pengeluar berikan justifikasi anda, manakah di antara dua faktor yang dinyatakan di atas adalah faktor yang lebih penting.

(20 marks/markah)

- (ii) **Both factors involve cost that will contribute towards the final product cost. Propose TWO (2) strategies to reduce product cost based on the two factors.**

Kedua-dua faktor melibatkan kos yang akan menghasilkan kos akhir produk. Berdasarkan dua faktor tersebut, cadangkan DUA (2) strategi untuk mengurangkan kos produk.

(20 marks/markah)

- Q2. [a] **Referring to Table Q2(i) and Q2(ii) state the MOST SUITABLE advanced machining process based on the given criteria and provide reasons why it was selected for the following cases;**

Merujuk kepada Jadual S2(i) dan S2(ii), nyatakan proses pemesinan termaju yang PALING SESUAI berdasarkan kriteria yang telah dinyatakan dan berikan sebab-sebab kenapa ianya dipilih bagi kes-kes berikut;

- (i) **Producing a mould from tool steel for injection moulding process with machining tolerances $\pm 0.02\text{mm}$, that have a deep cavity with the surface roughness of $1.00\mu\text{m}$.**

Menghasilkan acuan daripada bahan keluli alat untuk proses suntikan plastik dengan toleran pemesinan $\pm 0.02\text{mm}$, yang mempunyai rongga yang dalam dengan kekasaran permukaan $1.00\mu\text{m}$.

(25 marks/markah)

- (ii) **Producing 10 through holes with a radius of 0.50mm on ceramic material with 10.00mm thickness for turbine blade manufacturing. Surface roughness must not be beyond $1.50\mu\text{m}$ with machining tolerances at $\pm 0.03\text{mm}$.**

Pengerudian 10 lubang tebus berjajari 0.50mm pada ketebalan bahan seramik ialah 10.00mm untuk pembuatan kipas turbin. Kekasaran permukaan adalah tidak melebihi $1.50\mu\text{m}$ dengan toleran pemesinan $\pm 0.03\text{mm}$.

(25 marks/markah)

- (iii) Producing a groove on a carbon fiber for the chasis of F1 racing car with a surface roughness of $0.40\mu\text{m}$ and $\pm 0.05\text{mm}$ tolerances.

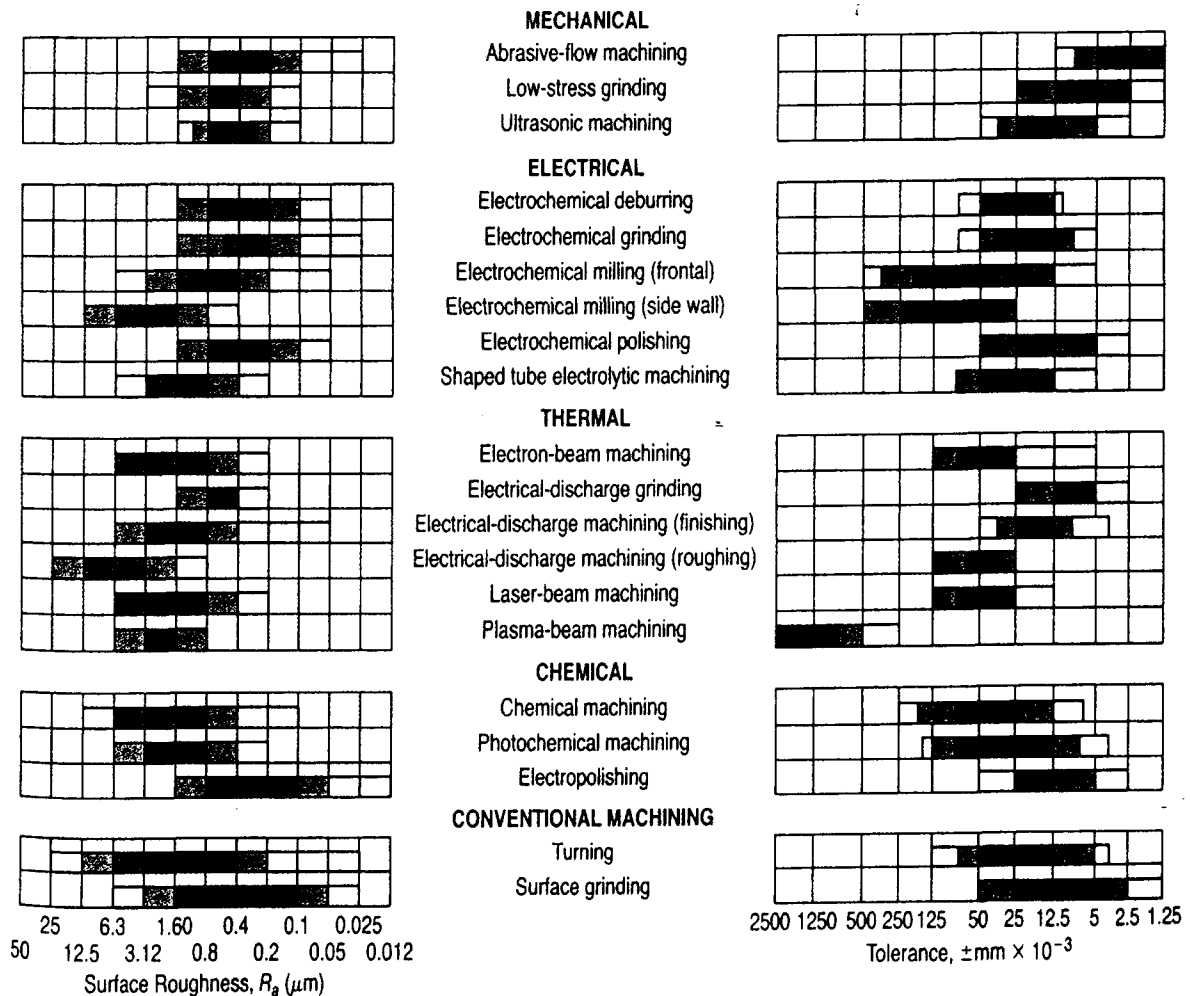
Menghasilkan satu alur pada bahan fiber karbon untuk bahagian chasis kereta lumba F1 dengan kekasaran permukaan $0.40\mu\text{m}$ dan toleran pemesinan $\pm 0.05\text{mm}$.

(25 marks/markah)

Table Q2(i): General characteristic of advanced machining process
Jadual S2(i): Kriteria umum proses pemesinan termaju

Process	Characteristics	Process parameters and typical material-removal rate or cutting speed
Chemical machining (CM)	Shallow removal on large flat or curved surfaces; blanking of thin sheets; low tooling and equipment cost; suitable for low production runs.	0.0025 – 0.1 mm/min
Electrochemical machining (ECM)	Complex shapes with deep cavities; highest rate of material removal among other nontraditional processes; expensive tooling and equipment; high power. Consumption; medium-to-high production quantity.	V: 5 – 25 DC; A: 1.5-8 A/mm ² ; 2.5 – 12 mm/min, depending on current density
Electrochemical grinding (ECG)	Cutting off and sharpening hard materials, such as tungsten-carbide tools; also used as a honing process; higher removal rate than grinding.	A: 1 – 3 A/mm ² ; Typically 25 mm ³ /s per 1000 A
Electrical-discharge machining (EDM)	Shaping and cutting complex parts made of hard materials; some surface damage may result; also used as a grinding and cutting process; expensive tooling and equipment.	V: 50 – 380; A: 0.1 – 500; Typically 300 mm ³ /min
Wire EDM	Contour cutting of flat or curvatural or curved surfaces; expensive equipment	Varies with material and thickness
Laser-beam machining (LBM)	Cutting and hole making on thin materials; heat-affected zone; does not require a vacuum; expensive equipment; consumes much energy.	0.50 – 7.5 m/min
Electron-beam machining (EBM)	Cutting and hole making on thin materials; very small holes and slots; heat-affected zone; requires a vacuum; expensive equipment.	1 – 2 mm ³ /min
Water-jet machining (WJM)	Cutting all types of nonmetallic materials; suitable for contour cutting of flexible materials; no thermal damages; noisy	Varies considerably with material
Abrasive water-jet machining (AWJM)	Single or multilayer cutting of metallic and nonmetallic materials.	Up to 7.5 m/min
Abrasive-jet machining (AJM)	Cutting, slotting, deburring, etching, and cleaning of metallic and nonmetallic materials; tends to round off sharp edges; can be hazardous.	Varies considerably with material

Table Q2(ii): Surface roughness and tolerances of advanced machining process
Jadual S2(ii): Kekasaran permukaan dan toleran proses pemesinan termaju



Note: (a) Depends on state of starting surface. (b) Titanium alloys are generally rougher than nickel alloys. (c) High current density areas. (d) Low current density areas.

Average application (normally anticipated values)
 Less frequent application (unusual or precision conditions)
 Rare (special operating conditions)

[b] Give THREE (3) reasons why advanced machining processes although requires huge investment are sometimes preferred, compared to the conventional machining processes.

Beri TIGA (3) sebab mengapa proses pemesinan termaju walaupun memerlukan pelaburan yang tinggi, adakalanya dipilih berbanding proses pembuatan konvensional.

(25 marks/markah)

- Q3. [a] Numerical control (NC) milling machine that is used for machining which operates with an open loop control system was found to give a dimensional error of more than 20 μ m. All attempt to overcome the predicament was deemed unsuccessful. Since buying a new NC machine is not an alternative, you have opted to seek a budget to upgrade the NC machine control system from the management. You have proposed two different type of control system i.e. control system AA and control system BB. The management has approved your budget request for the AA control system due to lower cost.**

Mesin pemilan kawalan berangka (NC) yang digunakan untuk kerja pemesinan beroperasi dengan sistem kawalan gelung terbuka telah didapati menghasilkan ralat dimensi melebihi 20 μ m. Semua cubaan untuk mengatasi masalah tersebut telah menemui jalan buntu. Memandangkan pembelian satu mesin NC yang baru bukan satu alternatif, maka anda telah memilih untuk memohon satu belanjawan untuk menaiktaraf sistem pengawal NC mesin tersebut daripada pihak pengurusan. Anda telah mencadangkan dua jenis sistem pengawal NC yang berlainan iaitu sistem kawalan AA dan sistem kawalan BB. Pihak pengurusan telah meluluskan permohonan anda untuk sistem kawalan AA kerana kosnya lebih rendah.

- (i) Name the AA type control system and BB type control system.**

Namakan sistem kawalan jenis AA dan sistem kawalan jenis BB.

(10 marks/markah)

- ii) Clarify briefly why is the AA control system cheaper than the BB control system?**

Terangkan secara ringkas mengapa sistem kawalan AA adalah lebih murah daripada sistem kawalan BB.

(20 marks/markah)

- iii) Why the AA type control system is better compared to the existing milling machine control system.**

Mengapakah, sistem kawalan AA yang dicadangkan adalah lebih baik daripada sistem kawalan asal mesin pemilan tersebut?

(30 marks/markah)

- [b] List and explain briefly all the required information/data for computer numerical control (CNC) machine that will ensures the machining operation perform effectively and efficiently.**

Senaraikan dan jelaskan secara ringkas semua maklumat/data yang diperlukan oleh mesin kawalan berangka (CNC) yang dapat memastikan operasi pemesinan dijalankan secara berkesan dan cekap.

(40 marks/markah)

- Q4. [a] Discuss FIVE (5) advantages of CNC machining compared to traditional machining.**

Bincangkan LIMA (5) kelebihan utama pemesinan CNC berbanding pemesinan tradisi.

(30 marks/markah)

- [b] Using simple sketch, label the coordinate system for Deckel FP4-60T CNC milling machine and the OKUMA LB15C CNC lathe machine**

Menggunakan lakaran yang ringkas, label sistem koordinat bagi mesin pemil CNC Deckel FP4-60T dan mesin pelarik CNC OKUMA LB15C.

(20 marks/markah)

- [c] Explain FOUR (4) components of internal control system for the DECKEL CNC milling machine.**

Terangkan EMPAT (4) komponen sistem kawalan dalaman untuk mesin pemil CNC DECKEL.

(30 marks/markah)

- [d] Explain what is “modal words” and “block-active words” in CNC programming. Give ONE (1) example for each.**

Terangkan apakah “perkataan modal” dan “perkataan teraktif blok” dalam pengaturcaraan KBB. Berikan SATU (1) contoh bagi setiap satunya.

(20 marks/markah)

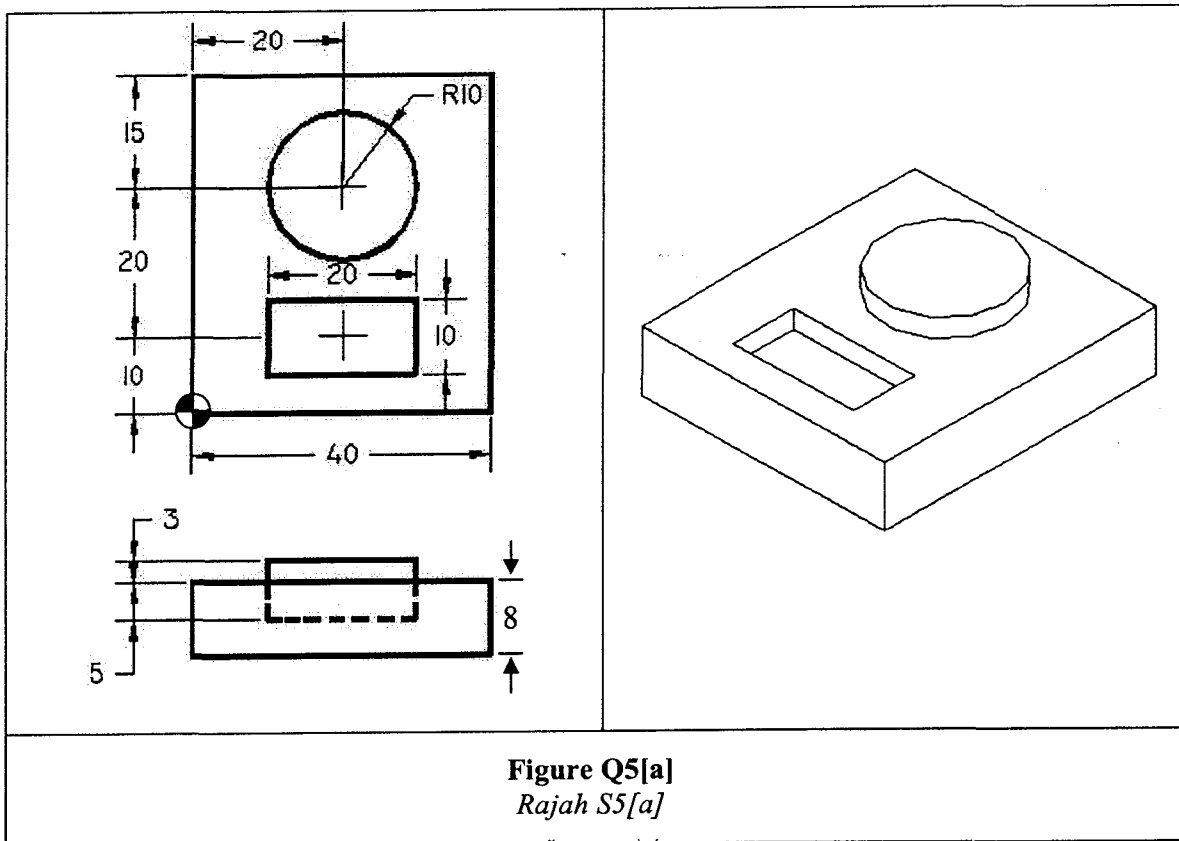
- Q5. [a] Write a CNC program for the workpiece described by an engineering drawing as in Figure Q5[a]. Use the G and M codes that are appropriate to the Dialog 12 controller with Canned Cycle for pin G87*3, followed by Canned Cycle for rectangular pocket G87*1 with a depth of 5mm from the top surface.**

All dimensions are in millimeter. Use the workpiece datum indicated in the drawing for your part program.

*Sediakan aturcara CNC untuk memesin bendakerja yang ditakrifkan oleh lukisan kejuruteraan seperti dalam Rajah S5[a]. Sila guna kod G dan M yang sepadan dengan pengawal Dialog 12 dengan Kitar “Canned” bagi pemotongan pin G87*3, diikuti dengan potongan poket segiempat tepat G87*1 dengan kedalaman 5mm daripada permukaan atas.*

Semua dimensi dalam millimeter. Gunakan datum bendakerja yang ditandakan di dalam lukisan untuk aturcara bahagian anda.

(50 marks/markah)



- [b] Explain in detail the G87*3 code for pin and the G87*1 for rectangular pocket used in your CNC program in Q5[a].

*Terangkan dengan terperinci kod G87*3 untuk pin dan G87*1 untuk poket segiempat tepat yang digunakan dalam aturcara CNC anda di S5[a]*

(30 marks/markah)

- [c] Explain why ballscrews are used for feed control in CNC machines.

Terangkan kenapa skru bebola digunakan untuk kawalan suapan dalam mesin CNC.

(20 marks/markah)

- Q6. [a] **Give definition of Rapid Prototyping, Rapid Tooling and Reverse Engineering.**

Berikan definisi Pencontohsulungan Pantas, Alatan Pantas dan Kejuruteraan Balikan.

(15 marks/markah)

- [b] **Describe the complete cycle of rapid prototyping process for model production from non-standard data, i.e. computed tomography (CT) scan data. Discuss the common problems associated with the process.**

Terangkan kitar lengkap proses pencontohsulungan pantas untuk menghasilkan model daripada data yang tidak piawai, contohnya data imbasan CT. Bincangkan masalah lazim yang dihadapi berkaitan dengan proses ini.

(35 marks/markah)

- [c] **Discuss the advantages and limitations of Rapid Prototyping (RP) in (1) design, (2) engineering analysis and planning, and (3) tooling and manufacturing.**

Bincangkan kelebihan dan batasan Pencontoh-Sulungan Pantas di dalam (1) rekabentuk, (2) analisis kejuruteraan dan perancangan dan (3) perkakasan dan pembuatan.

(50 marks/markah)