

UNIVERSITI MALAYA
UNIVERSITI MALAYA

PEPERIKSAAN IJAZAH SARJANA MUDA KEJURUTERAAN
EXAMINATION FOR THE DEGREE OF BACHELOR OF ENGINEERING

SESI AKADEMIK 2021/2022 : SEMESTER I
ACADEMIC SESSION 2021/2022 : SEMESTER I

KIX1001 : Matematik Kejuruteraan I
Engineering Mathematics I

Feb 2022
Feb 2022

Masa : 2 jam
Time : 2 hours

ARAHAN KEPADA CALON :
INSTRUCTIONS TO CANDIDATES :

Jawab semua soalan.
Answer all questions.



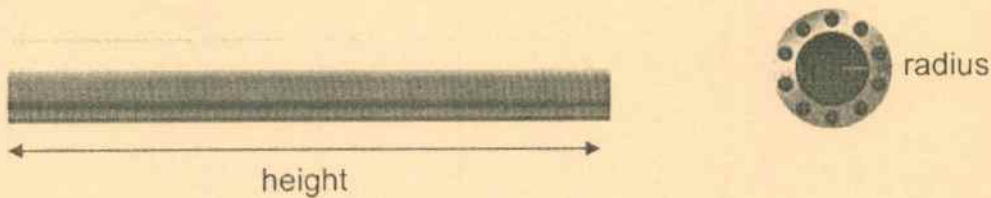
(Kertas soalan ini mengandungi 4 soalan dan 1 apendiks dalam 7 halaman yang dicetak)

(This question paper consists of 4 questions and 1 appendix on 7 printed pages)

Soalan 1
Question 1

- (a) Disiplin kejuruteraan reka bentuk paip mengkaji pengangkutan cecair yang cekap. Anda dikehendaki mereka bentuk paip yang stabil yang boleh membawa 200 liter cecair pada satu masa. Dengan mengandaikan bahawa ia adalah paip tertutup di kedua-dua penghujung, tentukan dimensi (jejari dan ketinggian dalam cm) paip yang akan meminimumkan jumlah bahan yang digunakan untuk membina paip tersebut dengan justifikasi.

The engineering discipline of piping design studies the efficient transport of fluid. You are required to design a stable pipe that can hold 200 litres of fluid at a time. Assuming that it is a closed ended pipe at both ends, determine the dimensions (radius and height in cm) of the pipe that will minimize the amount of material used to construct the pipe with justification.



Rajah 1 /Figure 1

(5 markah / marks)

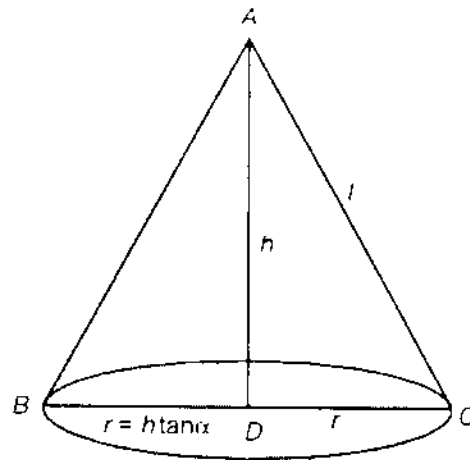
- (b) Ketegaran kilasan panjang kabel dikira dengan menggunakan formula $N = \frac{8\pi E l}{t^2 r^4}$. Jika l dikurangkan sebanyak 2%, r bertambah sebanyak 1.5%, t bertambah sebanyak 1.5%. Bolehkah kabel tersebut masih digunakan jika had yang dibenarkan untuk pengurangan ketegaran kilasan kabel adalah 15%?

The torsional rigidity of a length of a cable is calculated using the formula $N = \frac{8\pi E l}{t^2 r^4}$. If l is decreased by 2%, r is increased by 1.5%, t is increased by 1.5%. Can the cable still be used if the allowable limit for reduction in the torsional rigidity of a cable is 15%?

(3 markah / marks)

- (c) Sebuah produk ekzos berbentuk kon mempunyai ketinggian h dan sudut separa menegak α seperti ditunjukkan dalam Rajah 2. Jumlah kawasan A, termasuk tapak dikira. Sekiranya semasa pembuatan produk, h dan δ masing-masing mengalami ralat dengan kuantiti yang kecil δh dan $\delta\alpha$, carikan ralat kawasan tersebut. Tunjukkan bahawa jika $\alpha = \pi/6$, ralat 1% dalam h akan lebih kurang diimbangi dengan ralat -0.33° dalam α . [Petunjuk: luas permukaan melengkung = $\pi r l$, di mana l adalah panjang melengkung.]

A conical-shaped exhaust product has the height h and the semi-vertical angle α as shown in Figure 2. The total area A , including the base is calculated. If during manufacturing of the product, h and α are in error by small quantities δh and $\delta\alpha$ respectively, find the corresponding error in the area. Show that if $\alpha = \pi/6$, an error of 1% in h will approximately compensated by an error of -0.33° in α . [Hint: area of curved surface = $\pi r l$, where l is the curved length]



Rajah 2/ Figure 2

(7 markah / marks)

Soalan 2
Question 2

- (a) Diberikan bahawa matriks $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 4 & 5 \\ 0 & 4 & 3 \end{bmatrix}$ boleh dipepenjurukan. Cari matriks yang akan mempepenjurukan matriks A jika matriks pepenjurukan tersebut ialah $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 8 \end{bmatrix}$.

Given that matrix $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 4 & 5 \\ 0 & 4 & 3 \end{bmatrix}$ can be diagonalized. Find the matrix that will diagonalize matrix A if the diagonal matrix is $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 8 \end{bmatrix}$.

(7 markah / marks)

- (b) Sebuah syarikat pembangun perisian ingin melabur dalam tiga projek baru, iaitu projek A, B dan C yang dijangka akan memberi 5 %, 10 % dan 10 % kadar pulangan masing-masing. Namun, berdasarkan keutamaan pasaran, syarikat ini juga memutuskan bahawa amaun pelaburan projek B hendaklah dua kali ganda amaun pelaburan projek C. Sekiranya jumlah amaun pelaburan dan jumlah pulangan untuk ketiga-tiga projek adalah 27500 dan 2500 masing-masing, tentukan amaun yang dilabur dalam setiap projek menggunakan cara Cramer.

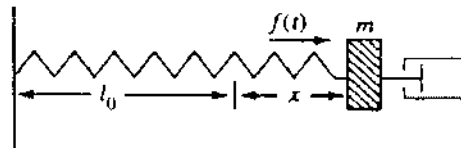
A software developer company would like to invest in three new projects, namely projects A, B and C, which are expected to give 5 %, 10 % and 10 % rates of return respectively. However, based on market preference, the company also decides that the amount invested for project B has to be twice the amount invested for project C. If the total investment amount and the total return for all three projects are 27500 and 2500 respectively, determine the amount invested for each project using the Cramer's method.

(8 markah / marks)

Soalan 3
Question 3

Sebuah spring dengan panjang asal ' l_0 ' mempunyai jisim ' m ' yang bersambungan dengannya dan sebuah pemuka meredam gerakan tersebut. Ia tertakluk kepada daya $f(t)$ memaksa gerakan seperti yang ditunjukkan dalam Rajah 4.

A spring of original length ' l_0 ' has a mass ' m ' attached to it and a dashpot damping the motion. It is subject to a force $f(t)$ forcing the motion as shown in Figure 4.



Rajah 4/ Figure 4

Input kepada sistem ini adalah fungsi, $f(t)$ dan keluaran adalah sesaran spring daripada panjang asalnya, $x(t)$. Sistem ini memenuhi persamaan 1:

The input to this system is the forcing function, $f(t)$ and the output is the displacement of the spring from its original length, $x(t)$. The system is satisfying the equation 1:

$$m \frac{d^2 x}{dt^2} + r \frac{dx}{dt} + kx = f(t) \quad (1)$$

- (i) Carikan semua penyelesaian pelengkap bagi sesaran spring selepas masa t . Biar $\lambda =$ punca dalam pengiraan.
Find all the possible complementary solutions for the displacement of the spring after time t . Let $\lambda =$ root in the calculation.

(5 markah / marks)

- (ii) Berdasarkan keputusan di bahagian b(i), rekabentuk nilai r untuk kes punca berulang supaya sesaran boleh dikurangkan, sekiranya m dan k diberikan 2 dan 2048 masing-masing. Seterusnya, carikan penyelesaian pelengkap. Nota: $r > 0$.
Based on the result in part b(i), design the value of r for repeated root case so that displacement can be minimized, if m and k are given as 2 and 2048 respectively. Hence, find the complementary solution. Note: $r > 0$.

(2 markah / marks)

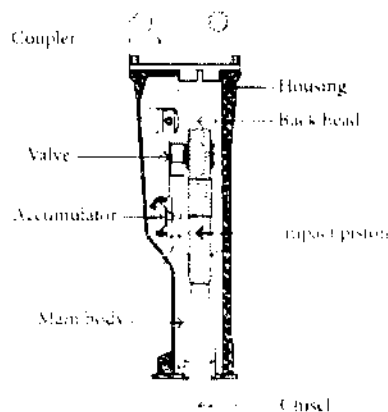
- (iii) Seterusnya, menyelesaikan jumlah penyelesaian sesaran untuk parameter (m, r , dan k) direkabentuk di bahagian b(ii) sekiranya $f(t) = te^t$. Lepas itu, anggarkan $x(t)$ apabila $t = 10$.
Hence, solve the total displacement solution for the designed parameters (m, r , and k) in part b(ii) if $f(t) = te^t$. Then, estimate $x(t)$ when $t = 10$.

(8 markah / marks)

Soalan 4
Question 4

- (a) Ciri tukul hentaman hidraulik (Rajah 5) boleh ditakrifkan oleh persamaan pembezaan tertib kedua berikut (persamaan 2). Berdasarkan nilai permulaan, cari penyelesaian tertentu menggunakan siri kuasa dan berikan penyelesaian dengan sekurang-kurangnya 5 sebutan penjumlahan separa.

Hydraulic impact hammer (Figure 5) characteristics can be defined by the following second order differential equation (equation 2). Based on the initial values, find the particular solution using power series and present the solution with at least 5 partial summation terms.



Rajah 5/ Figure 5

$$y'' - 6xy' + x^2y = 0 \tag{2}$$

$$y(0) = 2, \quad y'(0) = 1 \tag{3}$$

(12 markah / marks)

- (b) Tentukan jenis titik tunggal bagi persamaan pembezaan yang diberikan dan sama ada ia boleh diselesaikan dengan siri kuasa atau tidak.

Determine the singular point type of the given differential equations and whether they can be solved by power series or not.

Persamaan Pembezaan/ Differential Equation	Jenis titik tunggal/ Singular point type	Siri kuasa (Ya atau Tidak)/ Power series (Yes or No)
$8x^2y'' + 10xy' + (x - 1)y = 0$		
$y'' + x^4 y' + y = 0$		
$2(x - 1)^2 y'' + x^4 y' + y = 0$		

(3 markah / marks)

APENDIKS 1
APPENDIX 1

Jadual 1: Terbitan Trigonometri

Table 1: Trigonometry Differentiation Formula

$$\frac{d}{dx}(\sin x) = \cos x$$

$$\frac{d}{dx}(\cos x) = -\sin x$$

$$\frac{d}{dx}(\tan x) = (\sec x)^2$$

$$\frac{d}{dx}(\sec x) = \sec x \cdot \tan x$$

$$\frac{d}{dx}(\csc x) = -\csc x \cdot \cot x$$

$$\frac{d}{dx}(\cot x) = -(\csc x)^2$$

Jadual 2: Bentuk umum ODE tertib kedua dan strategi untuk penyelesaian

Table 2: Commons forms of 2nd order ODE and strategy to solve them

Forms	Strategy
Homogeneous linear differential equation with constant coefficients a, b, c $a \frac{d^2y}{dx^2} + b \frac{dy}{dx} + cy = 0$	Let $y(x) = e^{mx}$ and use characteristic equation
Nonhomogeneous linear differential equation with constant coefficients a, b, c in the form of $r(x) = e^{ax}P_n(x)$ $a \frac{d^2y}{dx^2} + b \frac{dy}{dx} + cy = r(x)$	Method of undetermined coefficients
All types of nonhomogeneous linear differential equation $\frac{d^2y}{dx^2} + p(x) \frac{dy}{dx} + q(x)y = r(x)$	Method of variation of parameters

TAMAT
END