Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	ENGINEERING MATHEMATICS IIE
COURSE CODE	:	BWM 10303
PROGRAMME	:	2 BEJ / 4 BEJ
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Determine the particular solution for $\frac{\cos^2 y}{3}\left(\frac{dy}{dx}\right) - \cos^2 x = 0$ where y(0) = 2.

(8 marks)

(b) For $\left(3x^3 + 3y + 1\right)dx + (3x + 6y^3 + 2)dy = 0$,

(i) Show that this equation is an exact equation.

(3 marks)

(ii) Solve the particular solution when $y(1) = 0$.

(7 marks)

(c) Formulate the particular solution for $2\frac{d^2y}{dx^2} - 5\frac{dy}{dx} - 3y = 0$ when $y(0) = 1, y'(0) = 0$

(6 marks)

Q2 (a) Transform $t^2 e^{-4t}$ to s domain using Laplace transform.

(4 marks)

(b) Calculate $\mathcal{L}\{3t - (3t+1)u(t-3)\}$

(5 marks)

(c) For $\frac{8s+13}{s^2 + 4s - 5}$,

(i) Simplify this equation using partial fraction.

(4 marks)

(ii) From Q2 (c) (i), transform the equation into time domain.

(1 marks)

(d) For a RLC circuit that contains an electromotive force *E*, a resistor *R*, an inductor *L*, and a capacitor *C* can be represented by a general equation as follows:

$$L\frac{dI}{dt} + RI + \frac{Q}{C} = E(t)$$

(i) Rewrite the equation as a second order differential equation using $I = \frac{dQ}{dt}$, where Q is the charge.

(1 mark)

(ii) Formulate the charge as a function of time $Q(t)$ using the second order differential equation from Q2 (d) (i), and Laplace transform, given $E(t) = e^{-2t}\cos t$, $L = R = C = 1$, and initial condition of $Q_0 = \frac{dQ_0}{dt} = 0$.

(9 marks)

(iii) Analyze the value of Q from Q2 (d) (ii), when circuit is switched on forever.

(2 marks)

Q3 Given $f(x)=\begin{cases} k, & \frac{-\pi}{2}<x<\frac{\pi}{2} \\ 0, & \frac{\pi}{2}<x<\frac{3\pi}{2} \end{cases}$, use $n=1,2,3,\ldots$.

(a) For the given periodic function,

(i) Sketch the periodic function for the interval of $\left[\frac{-3\pi}{2},\frac{3\pi}{2}\right]$.

(4 marks)

(ii) Determine whether the periodic function is an odd function, even function or neither odd nor even function.

(1 marks)

(b) Formulate some partial sums of the coefficients for the given periodic function.

i) a_o

(5 marks)

ii) a_n

(9 marks)

iii) b_n

(5 marks)

(c) Determine the Fourier series of the given function.

(1 marks)

Q4 (a) Determine a power series solution in power of x for the following differential equations.

(i) $y''+y=0$

(6 marks)

(ii) $y''-3y'+2y=0$

(9 marks)

(b) Given $I=\int_1^2 x^{-3}\ J_4\ dx$,

(i) Integrate the given equation.

(7 marks)

(ii) Solve the equation by using table of J_0 and J_1 in Table A.

(3 marks)

- END OF QUESTION –

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FORMULAE

Second-order Differential Equation

Characteristic equation: $am^2 + bm + c = 0$.		
Case	The roots of characteristic equation	General solution
1.	Real and different roots: m_1 and m_2	$y = Ae^{m_1 x} + Be^{m_2 x}$
2.	Real and equal roots: $m = m_1 = m_2$	$y = (A + Bx)e^{mx}$
3.	Complex roots: $m_1 = \alpha + \beta i$, $m_2 = \alpha - \beta i$	$y = e^{\alpha x}(A\cos \beta x + B\sin \beta x)$

Laplace Transform

$f(t)$	$F(s)$
a	$\frac{a}{s}$
e^{at}	$\frac{1}{s-a}$
$\sin at$	$\frac{a}{s^2+a^2}$
$\cos at$	$\frac{s}{s^2+a^2}$
$\sinh at$	$\frac{a}{s^2-a^2}$
$\cosh at$	$\frac{s}{s^2-a^2}$
t^n, $n = 1,2,3,...$	$\frac{n!}{s^{n+1}}$
$e^{at} f(t)$	$F(s-a)$
$t^n f(t)$, $n = 1,2,3,...$	$(-1)^n \frac{d^n}{ds^n} F(s)$
$H(t-a)$	$\frac{e^{-as}}{s}$
$f(t-a)H(t-a)$	$e^{-as}F(s)$
$\delta(t-a)$	e^{-as}
$\int_0^t f(u)g(t-u)\,du$	$F(s)\cdot G(s)$
y	$Y(s)$
y'	$sY(s) - y(0)$
y''	$s^2Y(s) - sy(0) - y'(0)$

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Fourier series

$$f(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi}{L}x + \sin\frac{n\pi}{L}x \right)$$

$$a_0 = \frac{1}{2L}\int_{-L}^{L} f(x)\,dx$$

$$a_n = \frac{1}{L}\int_{-L}^{L} f(x)\cos\frac{n\pi}{L}x\,dx$$

$$b_n = \frac{1}{L}\int_{-L}^{L} f(x)\sin\frac{n\pi}{L}x\,dx$$

Power Series Solution

$$y = \sum_{m=0}^{\infty} a_m x^m = a_0 + a_1 x + a_2 x^2 + \ldots$$

$$y' = \sum_{m=1}^{\infty} m a_m x^{m-1} = a_1 + 2a_2 x + 3a_3 x^2 + \ldots$$

$$y'' = \sum_{m=2}^{\infty} m(m-1) a_m x^{m-2} = 2a_2 + 3.2a_3 x + 4.3a_4 x^2 + \ldots$$

Bessel Equation

$$y(x) = \sum_{M=0}^{\infty} a_m x^{m+v}$$

$$\frac{d}{dx}\left[x^{-v} J_v(x)\right] = -x^{-v} J_{v+1}(x)$$

$$J_{v-1}(x) + J_{v+1}(x) = \frac{2v}{x} J_v(x)$$

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Table A

x	$J_0(x)$	$J_1(x)$	x	$J_0(x)$	$J_1(x)$	x	$J_0(x)$	$J_1(x)$
0.0	1.0000	0.0000	3.0	−0.2601	0.3391	6.0	0.1506	−0.2767
0.1	0.9975	0.0499	3.1	−0.2921	0.3009	6.1	0.1773	−0.2559
0.2	0.9900	0.0995	3.2	−0.3202	0.2613	6.2	0.2017	−0.2329
0.3	0.9776	0.1483	3.3	−0.3443	0.2207	6.3	0.2238	−0.2081
0.4	0.9604	0.1960	3.4	−0.3643	0.1792	6.4	0.2433	−0.1816
0.5	0.9385	0.2423	3.5	−0.3801	0.1374	6.5	0.2601	−0.1538
0.6	0.9120	0.2867	3.6	−0.3918	0.0955	6.6	0.2740	−0.1250
0.7	0.8812	0.3290	3.7	−0.3992	0.0538	6.7	0.2851	−0.0953
0.8	0.8463	0.3688	3.8	−0.4026	0.0128	6.8	0.2931	−0.0652
0.9	0.8075	0.4059	3.9	−0.4018	−0.0272	6.9	0.2981	−0.0349
1.0	0.7652	0.4401	4.0	−0.3971	−0.0660	7.0	0.3001	−0.0047
1.1	0.7196	0.4709	4.1	−0.3887	−0.1033	7.1	0.2991	0.0252
1.2	0.6711	0.4983	4.2	−0.3766	−0.1386	7.2	0.2951	0.0543
1.3	0.6201	0.5220	4.3	−0.3610	−0.1719	7.3	0.2882	0.0826
1.4	0.5669	0.5419	4.4	−0.3423	−0.2028	7.4	0.2786	0.1096
1.5	0.5118	0.5579	4.5	−0.3205	−0.2311	7.5	0.2663	0.1352
1.6	0.4554	0.5699	4.6	−0.2961	−0.2566	7.6	0.2516	0.1592
1.7	0.3980	0.5778	4.7	−0.2693	−0.2791	7.7	0.2346	0.1813
1.8	0.3400	0.5815	4.8	−0.2404	−0.2985	7.8	0.2154	0.2014
1.9	0.2818	0.5812	4.9	−0.2097	−0.3147	7.9	0.1944	0.2192
2.0	0.2239	0.5767	5.0	−0.1776	−0.3276	8.0	0.1717	0.2346
2.1	0.1666	0.5683	5.1	−0.1443	−0.3371	8.1	0.1475	0.2476
2.2	0.1104	0.5560	5.2	−0.1103	−0.3432	8.2	0.1222	0.2580
2.3	0.0555	0.5399	5.3	−0.0758	−0.3460	8.3	0.0960	0.2657
2.4	0.0025	0.5202	5.4	−0.0412	−0.3453	8.4	0.0692	0.2708
2.5	−0.0484	0.4971	5.5	−0.0068	−0.3414	8.5	0.0419	0.2731
2.6	−0.0968	0.4708	5.6	0.0270	−0.3343	8.6	0.0146	0.2728
2.7	−0.1424	0.4416	5.7	0.0599	−0.3241	8.7	−0.0125	0.2697
2.8	−0.1850	0.4097	5.8	0.0917	−0.3110	8.8	−0.0392	0.2641
2.9	−0.2243	0.3754	5.9	0.1220	−0.2951	8.9	−0.0653	0.2559

$J_0(x) = 0$ for $x =$ 2.40483, 5.52008, 8.65373, 11.7915, 14.9309, 18.0711, 21.2116, 24.3525, 27.4935, 30.6346
$J_1(x) = 0$ for $x =$ 3.83171, 7.01559, 10.1735, 13.3237, 16.4706, 19.6159, 22.7601, 25.9037, 29.0468, 32.1897