



INTERNAL ASSESSMENT APPROVAL FORM (INCLUDING COLLABORATIVE PROVISION)

This form is used to ensure that assessment specifications have been through an internal review process prior to external examination/approval and release to students. It should be completed for each assessment for a particular module. The assessment tasks, criteria and marking scheme should accompany this form.

PARTNER (and taught location if relevant):	Coleg Sir Gar				
EXTERNAL EXAMINER NAME:	Dr Arfan Ghani				
ASSESSMENT AUTHOR :	Ainsley Thomas				
MODULE TITLE:	Further Engineering Mathematics				
MODULE CODE:	PSDE5008		MODULE LEVEL:	5	
COMPONENT NO. (e.g. 1 of 2):	1 of 1		COMPONENT WEIGHTING (e.g. 50% of the module):	100%	
ASSESSMENT PERIOD	☐ Semester 1	☐ Semester 1 <i>Re-sit</i>	☒ Semester 2	☐ Semester 2 <i>Re-sit</i>	<i>Other, please state</i>
TYPE OF ASSESSMENT:	☐ Coursework		☒ Examination		☐ Practical
LANGUAGE OF ASSESSMENT:	English		TRANSLATION REQUIRED (Y/N):	N	
FOR EXAMINATIONS ONLY. SPECIFY BELOW ANY ADDITIONAL MATERIAL(S) TO BE USED IN THE EXAMINATION					
<i>This box will expand as you type</i>					

INTERNAL MODERATOR PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ☒		Comments
		YES	NO	
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation	☒	☐	
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)	☒	☐	
3	Tasks which conform to the assessment described in the module syllabus	☒	☐	
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).	☒	☐	
5	Clear criteria for assessment and guidance about how marking/grading will be applied	☒	☐	
6	Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references	☒	☐	
7	Reference to good academic conduct, for example referencing, plagiarism and Turnitin	☒	☐	
8	Actions to complete <i>This box will expand as you type</i>			
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
INTERNAL MODERATOR: I confirm that this version of the assessment specification is ready to be sent to the Partnership Team Leader				26-03-19

ONLY TO BE COMPLETED IF THE ASSESSMENT IS LINKED TO A COLLABORATIVE PARTNER

PARTNERSHIP TEAM LEADER PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ✓		Comments
		YES	NO	
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation			
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)			
3	Tasks which conform to the assessment described in the module syllabus			
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).			
5	Clear criteria for assessment and guidance about how marking/grading will be applied			
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8	Actions to complete <i>This box will expand as you type</i>			
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
PTL: I confirm that this version of the assessment specification is ready to be sent to the External Examiner				

UWTSD PROVISION: please submit the completed document to the appropriate Programme Director.

COLLABORATIVE PROVISION: please submit the completed document (or make available electronically) to the Partnership Team Leader. This must be in accord with specific arrangements for sharing electronic documents (e.g. via SharePoint or similar).

The assessment tasks, criteria and marking scheme should accompany this form



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Y Drindod Dewi Sant
University of Wales
Trinity Saint David

LOCATION: COLEG SIR GAR

LLEOLIAD: COLEG SIR GAR

LEVEL 5

LEFEL 5

EXAMINATION PERIOD
MAY 2019

CYFNOD ARHOLIADAU
MAI 2019

HNC ELECTRICAL AND ELECTRONIC ENGINEERING

MODULE CODE: PSDE5008 / SGEE5001

Further Engineering Mathematics

TIME: 2.5 HOURS

ANSWER ALL OF SECTION A

ANSWER THREE OUT OF FOUR IN SECTION B

Equipment or materials required – Calculators are permitted. Formulae sheets provided.

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Section A

- (a) A sample of 100 components were tested to failure to find its life time.

The results, to the nearest 100 hours, were:

Life (hundreds of hours) (x)	6	7	8	9	10	11	12
Frequency (f)	7	21	25	19	14	9	5

Calculate, to the nearest hour, the mean and standard deviation of this data, both to 2d.p. **Show your working for full marks.**

(7 marks)

- (b) During the manufacture of resistors, there may be a probability of $\frac{3}{5}$ for producing a resistor with an Ohmic value of exactly 1k. Use the **binomial distribution** to find the probability of selecting this exact value for

- (i) 1 resistor out of a batch of 3.
- (ii) at least 3 resistors out of a batch of 4.

(18 marks)

Section B

1. Use the integrating factor method to find the current in a RC circuit, given:

$$R = 20\Omega, C = 0.05, E = 20e^{-3t} \text{ and } I(0) = 0$$

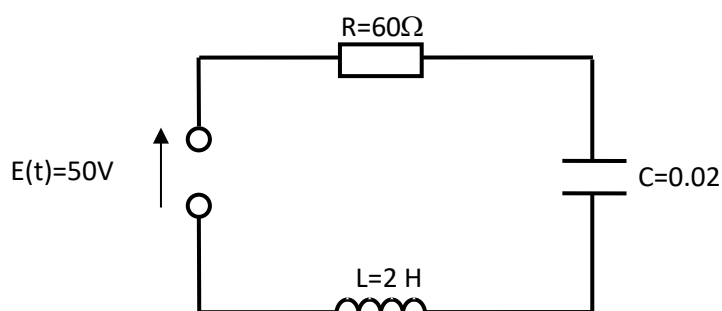
(25 marks)

2. Solve the following differential equation using Laplace transforms:

$$y'' + 3y' + 2y = e^t, \text{ given } y = 0 \text{ and } y' = 1 \text{ when } t = 0$$

(25 marks)

3. Determine the current $I(t)$ in the circuit below given that $I(0) = 0$ and $I'(0) = 10$



(25 marks)

4. Sketch the graph and determine the Fourier Series expansion of the function

$$f(x) = -4x \quad (-\pi < x < 0)$$

$$f(x) = 4x \quad (0 < x < \pi) \text{ and } f(x+2\pi) = f(x)$$

and find the first 4 non-zero terms of the series.

(25 marks)

Formulae

Integrating Factor for the Solution of First order Differential Equations

$$\frac{dy}{dx} + Py = Q$$

$$ye^{\int P dx} = \int e^{\int P dx} Q dx$$

Second order differential equations with constant coefficients

Where,

$$a \frac{d^2 y}{dx^2} + b \frac{dy}{dx} + cy = 0$$

auxiliary equation:

$$am^2 + bm + c = 0$$

with roots:

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Case 1 (real and different):

$$y = Ae^{m_1 x} + Be^{m_2 x}$$

Case 2 (real and equal):

$$y = e^{m_1 x}(A + Bx)$$

Case 3 (Complex roots):

$$y = e^{ax}(A \cos \beta x + B \sin \beta x)$$

Where,

$$a \frac{d^2 y}{dx^2} + b \frac{dy}{dx} + cy = r(x)$$

the solution has the form:

$$y = y_c + y_p$$

Where y_p is obtained from making the suggested substitution below:

$r(x)$	Trial Solution
$a \cos kx$	$C \sin kx + D \cos kx$
$a \sin kx$	$C \sin kx + D \cos kx$
ae^{kx}	Ce^{kx}

<i>R-L Circuit</i>	$E = RI + L \frac{dI}{dt}$
<i>R-C Circuit</i>	$E(t) = RI + \frac{1}{C} \int I dt$
<i>RLC Circuit</i>	$E = RI + L \frac{dI}{dt} + \frac{1}{C} \int I dt$

Standard derivatives

y	$\frac{dy}{dx}$
ax^n	nax^{n-1}
$a \sin(kx)$	$ka \cos(kx)$
$a \cos(kx)$	$-ka \sin(kx)$
ae^{kx}	kae^{kx}
$a \ln x$	$\frac{a}{x}$

Standard integrals

$\int ax^n dx$	$\frac{ax^{n+1}}{n+1} + c$ (except when $n = -1$)
$\int \cos ax dx$	$\frac{1}{a} \sin ax + c$
$\int \sin ax dx$	$-\frac{1}{a} \cos ax + c$
$\int e^{ax} dx$	$\frac{1}{a} e^{ax} + c$
$\int \frac{1}{x} dx$ or $\int x^{-1} dx$	$\ln x + c$
$\int \frac{1}{ax+b} dx$	$\frac{1}{a} \ln(ax+b) + c$

Fourier Series

$$f(x) = \frac{1}{2}a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

where

$$a_0 = \frac{2}{\pi} \int_0^{\pi} f(x) dx$$

$$a_n = \frac{2}{\pi} \int_0^{\pi} f(x) \cos nx \, dx$$

$$b_n = \frac{2}{\pi} \int_0^{\pi} f(x) \sin nx \, dx$$

Integration by parts'

$$\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$$

Laplace transforms

Function, $f(t)$	Laplace transform,
1	$\frac{1}{s}$
t	$\frac{1}{s^2}$
t^2	$\frac{2}{s^3}$
t^n	$\frac{n!}{s^{n+1}}$
e^{at}	$\frac{1}{s-a}$
e^{-at}	$\frac{1}{s+a}$
$t^n e^{-at}$	$\frac{n!}{(s+a)^{n+1}}$
$\sin bt$	$\frac{b}{s^2 + b^2}$
$\cos bt$	$\frac{s}{s^2 + b^2}$
$e^{-at} \sin bt$	$\frac{b}{(s+a)^2 + b^2}$
$e^{-at} \cos bt$	$\frac{s+a}{(s+a)^2 + b^2}$

$$L\{x\} = \bar{x}$$

$$L\{\dot{x}\} = s\bar{x} - x_0$$

$$L\{\ddot{x}\} = s^2 \bar{x} - sx_0 - \dot{x}_0$$

Statistics

For a frequency distribution: $\bar{x} = \frac{\sum fx}{\sum f}$ $\sigma = \sqrt{\frac{\sum f(x - \bar{x})^2}{\sum f}}$

The Poisson distribution

$$P(X = r) = \frac{e^{-\lambda} \lambda^r}{r!}$$

Where λ is the mean of the distribution.

The Standard Normal Curve

The conversion from normal distribution to standard normal distribution is achieved by using:

$$z = \frac{x - \mu}{\sigma}$$

where $\mu = \bar{x}$

The Binomial Distribution

$$\binom{n}{k} p^k q^{n-k}$$

Where

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$



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Solutions

Exam Solutions/Mark Scheme

SECTION A						Qu total
a)	x	f	xf	$f(x-\bar{x})^2$		
	6	7	42	46.957		
	7	21	147	53.090		
	8	25	200	8.703		
	9	19	171	3.194		
	10	14	140	27.833		
	11	9	99	52.273		
	12	5	60	58.141		
	Σ	100	859	250.191	3	
	$\bar{x} = \frac{859}{100} = 8.59$				2	
	$\sigma = \sqrt{\frac{250.191}{100}} = 1.58$				2	7
b)	if $p = 0.6$				2	
	$q = 1 - 0.6 = 0.4$					
(i)	$n=3$	$P(1k) = \binom{3}{1} p^1 q^{3-1}$				
		$= \binom{3}{1} 0.6^1 (0.4)^2$				
		$= 0.288$		5		
(ii)	$n=3$	either 3 or 4				
		$P(3) = \binom{4}{3} (0.6)^3 (0.4)$				
		$= 0.3456$		4		
		$P(4) = \binom{4}{4} (0.6)^4 (0.4)^0$				
		$= 0.1296$		4		
		$\therefore P(3 \text{ or } 4) = 0.3456 + 0.1296$				
		$= 0.4752$		3	18	25

Exam Solutions/Mark Scheme

SECTION B.				Qu total
1.	$R = 20 \quad C = 0.05 \quad E = 20e^{-3t}$ $I(0) = 0$ $RI + \frac{1}{C} \int I dt = E(t)$ $R \frac{dI}{dt} + \frac{1}{C} I dt = \frac{dE}{dt}$ Since $E(t) = 20e^{-3t}$ $\frac{dE}{dt} = -60e^{-3t}$ $20 \frac{dI}{dt} + \frac{1}{0.05} I dt = -60e^{-3t}$ $\frac{dI}{dt} + I dt = -3e^{-3t}$ $\int P dt = \int 1 dt = t$ $IF = e^t$ $\therefore Ie^t = \int e^t (-3e^{-3t}) dt$ $= \int -3e^{-2t} dt$ $Ie^t = \frac{3}{2} e^{-2t} + C$ Since $I(0) = 0$ $0 = \frac{3}{2} e^0 + C$ $C = -\frac{3}{2}$ $\therefore Ie^t = \frac{3}{2} e^{-2t} - \frac{3}{2}$ or $I = \frac{3}{2} e^{-3t} - \frac{3}{2} e^{-t}$			
		2		
		2		
		2		
		2		
		2		
		2		
		3		
		3		
		2		
		2		
		3		25

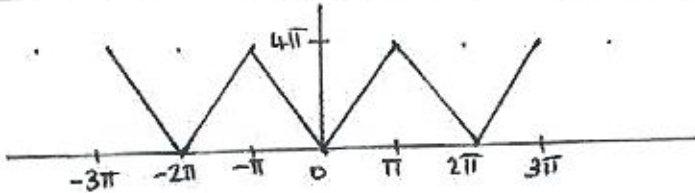
Exam Solutions/Mark Scheme

			Qu total
2.	$y'' + 3y' + 2y = e^t \quad y=0, y'=1 \text{ when } t=0$ $(s^2\bar{y} + s y_0 - y_1) + 3(s\bar{y} - y_0) + 2\bar{y} = \frac{1}{s-1}$ $s^2\bar{y} - 1 + 3s\bar{y} + 2\bar{y} = \frac{1}{s-1}$ $\bar{y}(s^2 + 3s + 2) = \frac{1}{s-1} + 1$ $\bar{y}(s+1)(s+2) = \frac{1+s-1}{s-1}$ $\bar{y} = \frac{s}{(s-1)(s+1)(s+2)}$ $\frac{s}{(s-1)(s+1)(s+2)} = \frac{A}{(s-1)} + \frac{B}{(s+1)} + \frac{C}{(s+2)}$ $s = A(s+1)(s+2) + B(s-1)(s+2) + C(s-1)(s+1)$ put $s = -1$ $-1 = A(0) + B(-2)(-1) + C(0)$ $-1 = -2B \rightarrow B = 0.5$ put $s = -2$ $-2 = A(0) + B(0) + C(-3)(-1)$ $-2 = 3C \rightarrow C = -\frac{2}{3}$ put $s = 1$ $1 = A(2)(3) + B(0) + C(0)$ $1 = 6A \rightarrow A = \frac{1}{6}$ $\therefore \mathcal{L}^{-1} \left\{ \frac{1}{6(s-1)} + \frac{1}{2(s+1)} - \frac{2}{3(s+2)} \right\}$ $y = \frac{1}{6} e^t + \frac{1}{2} e^{-t} - \frac{2}{3} e^{-2t}$	 3 2 2 2 2 1 2 2 2 2 2 3	25

Exam Solutions/Mark Scheme

			Qu total
$\frac{dI}{dt} = -0.858 A e^{-0.858t} - 29.142 B e^{-29.142t}$	4		
$I'(0) = 10$			
$10 = -0.858 A e^0 - 29.142 B e^0$	2		
$10 = -0.858 A - 29.142 B$	1		
$\textcircled{1} \times 0.858$			
$0 = 0.858 A + 0.858 B$	1		
$10 = -28.284 B$			
$B = -0.354$	1		
$0 = A - 0.354$			
$A = 0.354$	1		
$\therefore I = 0.354 e^{-0.858t} - 0.354 e^{-29.142t}$	2		25

Exam Solutions/Mark Scheme

			Qu total
4	 Even function $\therefore b_n = 0.$ $a_0 = \frac{2}{\pi} \int_0^{\pi} 4x \, dx$ $= \frac{2}{\pi} \left[\frac{4x^2}{2} \right]_0^{\pi}$ $= \frac{2}{\pi} \left[2(\pi)^2 \right] - \frac{2}{\pi} \left[2(0) \right]$ $a_0 = 4\pi$ $a_n = \frac{2}{\pi} \int_0^{\pi} f(x) \cos nx \, dx$ $= \frac{2}{\pi} \int_0^{\pi} 4x \cos nx \, dx$ Let $u = 4x$ $\frac{dv}{dx} = \cos nx$ $\frac{du}{dx} = 4$ $v = \frac{1}{n} \sin nx$ By parts: $\int 4x \cos nx \, dx = (4x) \left(\frac{1}{n} \sin nx \right)$ $- \int \frac{1}{n} \sin nx \cdot 4 \, dx$	3 1 2 1 4 3	

Exam Solutions/Mark Scheme

		Qu total
$= \frac{4x}{n} \sin nx - \int \frac{4}{n} \sin nx dx$		
$= \frac{4x}{n} \sin nx + \frac{4}{n^2} \cos nx$	3	
$\therefore a_n = \frac{2}{\pi} \left[\frac{4x}{n} \sin nx + \frac{4}{n^2} \cos nx \right]_0^{\pi}$	2	
$= \frac{2}{\pi} \left[\frac{4\pi}{n} \sin(n\pi) - \frac{4}{n^2} \cos(n\pi) \right]$		
$- \frac{2}{\pi} \left[\frac{4\pi}{n} \sin 0 + \frac{4}{n^2} \cos 0 \right]$	2	
$= \frac{2}{\pi} \left[\frac{4}{n^2} \cos(n\pi) \right] - \frac{2}{\pi} \left[\frac{4}{n^2} \right]$		
$a_n = \frac{8}{\pi n^2} [\cos(n\pi) - 1]$	1	
$n=1, a_1 = \frac{8}{\pi(1)^2} [\cos \pi - 1] = -\frac{16}{\pi(1)^2}$		
$n=2, a_2 = \frac{8}{\pi(2)^2} [\cos 2\pi - 1] = 0$		
$n=3, a_3 = \frac{8}{\pi(3)^2} [\cos 3\pi - 1] = -\frac{16}{\pi(3)^2}$		
$a_4 = 0.$	2	
$\therefore f(x) = \frac{1}{2}(4\pi) - \frac{16}{\pi(1)^2} \cos x$		
$- \frac{16}{\pi(3)^2} \cos 3\pi - \frac{16}{\pi(5)^2} \cos 5x$		
$= 2\pi - \frac{16}{\pi} \cos x - \frac{16}{9\pi} \cos 3\pi - \frac{16}{25\pi} \cos 5x \dots$	1	
		25