UNIVERSITY
OF
JOHANNESBURG

FACULTY OF SCIENCE

	Examiner	Moderator
Paper 1 30 Marks		
Paper 2 70 Marks		
EM/100		

	Examiner	Moderator
SM		
EM		
FM		

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS

NATIONAL DIPLOMA IN ENGINEERING: ELECTRICAL ENGINEERING

MODULE: ENGINEERING MATHEMATICS 3 (MAT3AW3)

CAMPUS: DFC

ASSESSMENT: JUNE EXAMINATION 2018

(PAPER 2)

DATE: 31 MAY 2018   SESSION: 12:30-15:30

ASSESSOR: DR SM SIMELANE

MODERATOR: DR T MASEBE

DURATION: 180 MINUTES   MARKS: 100

INITIALS AND SURNAME: _____

STUDENT NUMBER: _____

CONTACT NUMBER: _____

NUMBER OF PAGES: 17 PAGES (INCLUDING COVER PAGE)

INSTRUCTIONS: WRITE YOUR STUDENT NUMBER AND PARTICULARS IN THE SPACE PROVIDED.
ANSWER ALL QUESTIONS IN THE SPACES PROVIDED.
USE ONLY A PEN FOR WRITING AND DRAWING (BLACK OR BLUE).

THIS EXAM IS ASSESSING SKILLS FOR SOLVING WELL-DEFINED ENGINEERING PROBLEMS AS OUTLINED IN ELO 1.

REQUIREMENTS: INFORMATION BOOKLET (AS ISSUED TO YOU IN THE EXAM)

Question 1
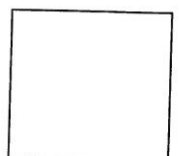
Determine the following

   a. $L\{(2t - 5)H(t - 2)\}$ (3)

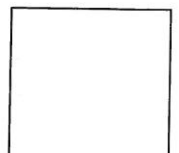   b. $L^{-1}\left\{\dfrac{2p+5}{p^2+2p+10}\right\}$ (4)

c. $\frac{1}{D^2+D-5}\{3 + 2t^2\}$ (4)

d. $\dfrac{1}{D^2+4D}\left\{\begin{matrix} \sin t \\ e^{2t} \end{matrix}\right\}$ (4)

e. $\int_{-\pi}^{0} \sin nx \; dx$ (4)

f. Is the function $g(t) = \begin{cases} 2t, & -2 \leq t < 0 \\ t^2, & 0 \leq t < 2 \end{cases}$ odd or even? Prove. (2)
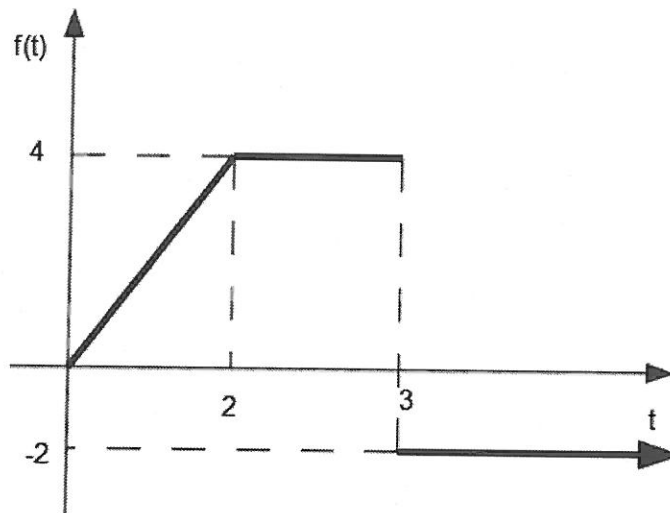
Question 2

Given the function $f(t)$ as

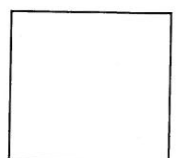a. Express the function $f(t)$ in unit step functions.   (2)

b. Express the function $f(t)$ in found above in Heaviside form. **Fully simplify.**   (2)

c. Compute the Laplace transforms of $f(t)$.   (4)

Question 3

Determine the unique solutions of the following differential equations by using the **Laplace Transforms**, subject to the indicated initial conditions.

a. $y''(t) + 4y(t) = \begin{cases} 0, & 0 \le t < 2 \\ 6, & t \ge 2 \end{cases}$ subject to $y(0) = 1$ and $y'(0) = 3$.   (8)

b. $y''(t) + 4y'(t) + 6y(t) = 0$, subject to $y(0) = 3$ and $y'(0) = 2$ (6)

Question 4

a. The mathematical model of a hypothetical system is described by the following differential equation

$$y'' + 4y' + 3y = 2t - 1.$$

Using **Laplace Transforms**, determine the motion $y(t)$ of this system if the initial displacement is $y(0) = 0$ and the initial velocity applied to the system is $y'(0) = 0$. Discuss the motion as $t \to \infty$.

(8)

b. Use **D-Operator Methods** to solve the differential equation for $y(t)$ and use the given initial conditions to determine the particular solution.   (10)

Question 5

Use **D-Operator Methods** to solve

a. $(D^2 + 2D - 24)x = e^t(t^2 - 2)$

(6)

b. $\frac{d^2y}{dt^2} - 3\frac{dy}{dt} + 2y = e^t \sin t$ (7)

c.   Solve for **x** only

$$\frac{dx}{dt} + y - 3x + 1 = 0$$
$$\frac{dy}{dt} - y = 4e^t$$

(10)

Question 6

a. Find a Fourier series for the following function

$$f(x) = \begin{cases} 2x & -4 \leq x < 0 \\ 0 & 0 \leq x < 4 \end{cases}; \qquad f(x) = f(x + 8) \qquad (13)$$

b. The table below defines a discrete function $f(x)$ of period 360^0. Determine the Fourier series of $f(x)$ up to the second harmonic. (Work to 2 decimal places)   (5)

x^0	0	60	120	180	240	300
$f(x)$	0	11,5	4	0	-11,5	-4

End of assessment – Total 102 marks available

Use this space if you want to redo any question(s). Please indicate clearly at the relevant question(s) that the solution is on this page.