Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	ENGINEEERING MATHEMATICS
COURSE CODE	:	BFC 25103
PROGRAMME	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Evaluate equation $y'' - 3y' - 4y = e^{3x}$ using the Laplace transform, with initial conditions $y(0) = -5$ and $y'(0) = -1$.

(5 marks)

(b) **Figure Q1(b)** shows a mass of *5kg*, in a water tank, is connected with a spring. The mass is pulled down as far as *x* with an initial Force of $F_0 = 4N$. The spring coefficient and the damping coefficient are known, $k = 10N/m$ and $b = 15kg/s$, respectively

(i) Derive the empirical equation of the homogeneous solution

(8 marks)

(ii) Compute the homogeneous solution if initial conditions are given, $y(0) = 1$ and $y'(0) = -7$.

(6 marks)

(iii) If the function of Force at particular time is given as $F(t) = F_0 \sin \omega_0^2 t$. Determine the particular solution.

(5 marks)

(iv) Evaluate the General equation of non-homogeneous solution.

(3 marks)

Note that $F = m\,a$, and $\omega_0 = \sqrt{\frac{k}{m}}$.

Q2 (a) A new mosque will be built in Kluang Town. As part of the design, the mosque is equipped with a minaret with a cone-shaped roof on top of it. In order to suit the minaret, the cone-shaped roof must follow the following function.

$$h = 64 - \sqrt{w^2 + l^2}$$

Where *h* is height of the roof, *w* is half width of the roof, *l* is half horizontal length of the roof.

As the engineer of this project, you need to model the minaret and its roof in BIM software where you need a rough sketch as a guide. Sketch the cone-shaped roof, the contour lines and the level curves at heights 0, 15 and 28m, respectively.

(8 marks)

(b) **Figure Q2(b)** illustrates the 3D topography of a land plot to be developed. Based on computer modelling, the original terrain could be represented by the following equation

$$z = x^4 + x \ln y + \sin x,$$

where x is horizontal distance at x-direction, y is horizontal distance at y-direction, and z is ground level.

(i) Compute the slope equation of the terrain at x and y direction.

(5 marks)

(ii) Evaluate the slope of x and y direction at coordinate (4, 5).

(5 marks)

Q3 (a) Consider a solid under the plane $z = 3 - x - y$ that lies above the circle $x^2 + y^2 = 4$ in the first quadrant.

(i) Identify and sketch the region of integration.

(3 marks)

(ii) Why are polar coordinates a better choice for the given solid? Explain your answer.

(4 marks)

(iii) Find the surface area above the solid

(6 marks)

(b) Given a triple integral

$$\iiint_G z^2\sqrt{x^2+y^2+z^2}\,dV$$

where G is the solid enclosed by $-\sqrt{36-x^2} \le y \le \sqrt{36-x^2}$, $0 \le z \le \sqrt{36-x^2-y^2}$, and $-6 \le x \le 6$

(i) Which method is the best choice for evaluating the integrals? Why? Explain your answer.

(4 marks)

(ii) Use spherical coordinates to evaluate the integral.

(6 marks)

(c) Evaluate

$$\iint_R \frac{dx\,dy}{\sqrt{1-x^2-y^2}}$$

where R is the right half-disk of radius ½ and centered at (0, ½).

(7 marks)

Q4 (a) Given a cylinder $x^2 + y^2 = 1$ and a plane $x + y = 1$.

(i) Find a vector-valued function $r(t)$ that represents the curve of the intersection of the given cylinder and plane.

(4 marks)

(ii) Calculate the unit tangent vector, $T(t)$.

(3 marks)

(b) Given the force field

$$\mathbf{F}(x, y, z) = (z^3 - 2xy)\mathbf{i}\ x^2\mathbf{j} + 3xz^2\ \mathbf{k}$$

(i) Show that **F** is a conservative vector fields.

(4 marks)

(ii) Find its potential function (ϕ).

(7 marks)

(c) Use Green's theorem to evaluate the integral

$$\oint_C (e^x + y^2)\,dx + (e^y + x^2)dy$$

where C is the boundary of the region enclosed by $y = x^2$ and $x = y^2$, and curve C is oriented counter-clockwise.

(7 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION	:	II/ 2020/2021	PROGRAMME CODE	:	BFF
COURSE NAME	:	ENGINEERING MATHEMATICS	COURSE CODE	:	BFC 25103

Figure Q1(b): Mass spring damping system

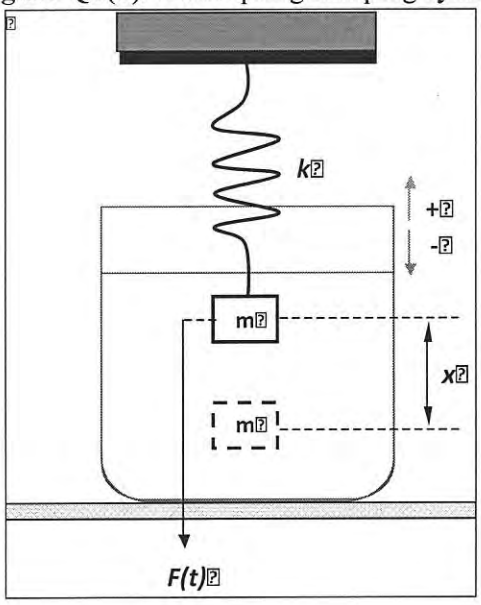

Figure Q2(b): Topography of the land