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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

TERBUKA

COURSE NAME	:	ENGINEERING MATHEMATICS III
COURSE CODE	:	BEE21503 / BWM20403
PROGRAMME	:	BEV / BEJ
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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Q1 (a) If $z = \sin(5z) + 3x^2y + e^{2y}$, show that

$$\left(\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y}\right)(5\cos(5z) - 1) = -6xy - 3x^2 - 2e^{2y}$$

(9 marks)

(b) State **TWO (2)** applications/usages of partial differentiation.

(2 marks)

(c) The radius, r and height, z of a cylinder are changed with time. If the radius and height of the cylinder are 3 cm and 7 cm respectively and both of them increase at the rate of 0.4 cm/s, calculate the rate of change for the volume of the cylinder. (Hint: volume of the cylinder is $V = \pi r^2 z$)

(8 marks)

(d) It is given that $f(x, y) = x^2y - 5xy - 3$, if the value of (x, y) varies from (3, 2) to (3.03, 1.98), find the approximate change of the function.

(6 marks)

Q2 (a) (i) Sketch a solid which is enclosed by a cylinder $x^2 + y^2 = 16$, plane $z = 5 - y$ and xy plane.

(5 marks)

(ii) Compute the volume of the solid in **Q2 (a) (i).**

(9 marks)

(b) By changing to spherical coordinate, evaluate

$$\int_{-2}^{2}\int_{-\sqrt{4-x^2}}^{\sqrt{4-x^2}}\int_{0}^{\sqrt{4-x^2-y^2}} z^2(x^2+y^2+z^2)\,dz\,dy\,dx$$

(11 marks)

Q3 (a) Evaluate $\int_c y^2\, dx + (xy - x^2)dy$ along path C_1 and C_2 from (0, 0) to (3, 9). Path C_1 is a straight line and path C_2 is the parabolic path $y = x^2$.

(10 marks)

(b) Find the work done by force field $\boldsymbol{F}(x, y) = 3x^2\, \boldsymbol{i} + y^2\boldsymbol{j}$ on a particle when it moves from (0, 0) to (0, $-\pi$) along the curves C3 and C4 in **Figure Q3 (a).** Judge whether the force, **F** is conservative or non-conservative and give your explanation.

(15 marks)

Q4 (a) By using the Divergence theorem, solve the flux coming out from a cone given by $z = 9 - \sqrt{x^2 + y^2}$, where $\boldsymbol{F} = 5x\boldsymbol{i} + 5y\boldsymbol{j} + 5\boldsymbol{k}$.

(11 marks)

(b) If σ is a portion of a paraboloid $z = 16 - (x^2 + y^2)$, oriented outward where C is the boundary of σ in the xy plane. Find the line integral $\oint_c \boldsymbol{F} \cdot d\boldsymbol{r}$ by using the Stokes' Theorem, if $\boldsymbol{F} = 3z\, \boldsymbol{i} + 2x\boldsymbol{j} + 6y\boldsymbol{k}$.

(14 marks)

- END OF QUESTIONS -

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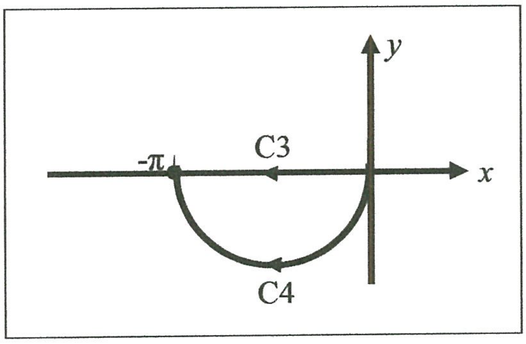

Figure Q3(a)

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FORMULAS

Polar coordinate

$x = r\cos\theta,\ \ y = r\sin\theta,\ \ \theta = \tan^{-1}(y/x)$, and $\iint_R f(x,y)dA = \iint_R f(r,\theta)\, r\, dr\, d\theta$

Cylindrical coordinate

$x = r\cos\theta,\ \ y = r\sin\theta,\ \ z = z$ and $\iiint_G f(x,y,z)dV = \iiint_G f(r,\theta,z) r\, dz\, dr\, d\theta$

Spherical coordinate

$x = \rho\sin\varphi\cos\theta,\ \ y = \rho\sin\varphi\sin\theta,\ \ z = \rho\cos\phi$, then $x^2 + y^2 + z^2 = \rho^2$, for $0 \le \theta \le 2\pi$,

$0 \le \varphi \le \pi$, and $\iiint_G f(x,y,z)dV = \iiint_G f(\rho,\phi,\theta)\rho^2 \sin\phi\, d\rho\, d\phi\, d\theta$

$$A = \iint_R dA$$

$m = \iint_R \delta(x,y)dA$, where $\delta(x,y)$ is a density of lamina

$$V = \iint_R f(x,y)\, dA$$

$$V = \iiint_G dV$$

$$m = \iiint_G \delta(x,y,z)dV$$

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If f is a differentiable function of x, y and z, then the

Gradient of f, grad $f(x,y,z) = \nabla f(x,y,z) = \frac{\partial f}{\partial x}\mathbf{i} + \frac{\partial f}{\partial y}\mathbf{j} + \frac{\partial f}{\partial z}\mathbf{k}$

If $\mathbf{F}(x,y,z) = M\mathbf{i} + N\mathbf{j} + P\mathbf{k}$ is a vector field in Cartesian coordinate, then the

Divergence of $\mathbf{F}(x,y,z)$, div $\mathbf{F} = \nabla\cdot\mathbf{F} = \frac{\partial M}{\partial x} + \frac{\partial N}{\partial y} + \frac{\partial P}{\partial z}$

Curl of $\mathbf{F}(x,y,z)$, curl $\mathbf{F} = \nabla\times\mathbf{F} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ M & N & P \end{vmatrix} = \left(\frac{\partial P}{\partial y} - \frac{\partial N}{\partial Z}\right)\mathbf{i} - \left(\frac{\partial P}{\partial x} - \frac{\partial M}{\partial Z}\right)\mathbf{j} + \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right)\mathbf{k}$

F is conservative vector field if Curl of **F** = 0.

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FORMULA

Surface Integral

Let S be a surface with equation $z = g(x, y)$ and let R be its projection on the xy-plane.

$$\iint_S f(x,y,z)\,dS = \iint_R f(x,y,g(x,y))\sqrt{1+\left(\frac{\partial z}{\partial x}\right)^2+\left(\frac{\partial z}{\partial y}\right)^2}\,dA$$

Gauss's Theorem

$$\iint_S \mathbf{F}\cdot\mathbf{n}\,dS = \iiint_G \nabla\cdot\mathbf{F}\,dV$$

Stokes' Theorem

$$\iint_S (\nabla\times\mathbf{F})\cdot\mathbf{n}\,dS = \int_C \mathbf{F}\cdot d\mathbf{r}$$