

QQQ – Further Pure 1 – Chapter 6 – Taylor Series (Version 2)

Total Marks: 25

(25 = Platinum, 23 = Gold, 20 = Silver, 17 = Bronze)

1. The displacement x metres of a particle at time t seconds is given by the differential equation

$$\frac{d^2x}{dt^2} + x + \cos x = 0$$

When $t = 0$, $x = 0$ and $\frac{dx}{dt} = \frac{1}{2}$.

Find a Taylor series solution for x in ascending powers of t , up to and including the term in t^3 .

(5)

(Total 5 marks)

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2.

- (a) Find the Taylor expansion of $\cos 2x$ in ascending powers of $\left(x - \frac{\pi}{4}\right)$ up to and including the term in $\left(x - \frac{\pi}{4}\right)^5$. **(5)**

- (b) Use your answer to (a) to obtain an estimate of $\cos 2$, giving your answer to 6 decimal places. **(3)**

(Total 8 marks)

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3.

$$y = \ln(e^{2x} \cos 3x) \quad -\frac{1}{2} < x < \frac{1}{2}$$

(a) Show that

$$\frac{dy}{dx} = 2 - 3 \tan 3x \quad (2)$$

(b) Determine $\frac{d^4y}{dx^4}$ **(3)**

(c) Hence determine the first 3 non-zero terms in ascending powers of x of the Maclaurin series expansion of $\ln(e^{2x} \cos 3x)$, giving each coefficient in simplest form. **(3)**

(d) Use the Maclaurin series expansion for $\ln(1 + x)$ to write down the first 4 non-zero terms in ascending powers of x of the Maclaurin series expansion of $\ln(1 + kx)$, where k is a constant. **(1)**

(e) Hence determine the value of k for which

$$\lim_{x \rightarrow 0} \left(\frac{1}{x^2} \ln \frac{e^{2x} \cos 3x}{1 + kx} \right)$$

exists. **(3)**

(Total 12 marks)