



EASTERN UNIVERSITY, SRI LANKA
DEPARTMENT OF MATHEMATICS
FIRST EXAMINATION IN SCIENCE - 2011/2012
FIRST SEMESTER (Jan./Feb., 2014)
MT 151 - MATHEMATICA
(Re-Repeat)

Answer all questions

Time : Two hours

1. (a) If x is an approximation to \sqrt{a} , it can be shown that $\frac{1}{2} \left(x + \frac{a}{x} \right)$ is a better approximation. Use NestList to observe the first 10 approximations obtained in computing $\sqrt{3}$, starting with $x = 100$.
- (b) The 20th prime number is 71. Find all the numbers less than 71 which are not prime.
- (c) i. Factor $4x^{\frac{2}{3}} + 8x^{\frac{1}{3}} + 4$.
ii. Simplify the given expression $\frac{\left(\frac{2}{x} - 3\right)}{1 - \frac{1}{x-1}}$.
- (d) i. Evaluate $\int \frac{x^5 + x^2 + x + 2}{(x^2 + 1)^2} dx$.
ii. Evaluate $\lim_{x \rightarrow 1^+} \left(\frac{1}{\ln x} - \frac{1}{x-1} \right)$.
iii. Find the third derivative of the function $g(t) = t^3 - \sqrt{t} + e^{-2t}$.

(c) Let $A = \begin{pmatrix} 3 & -1 & 2 & 1 \\ 2 & 7 & -3 & 4 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & -1 \\ 3 & 2 \\ -4 & -3 \\ 0 & -2 \end{pmatrix}$. Find the A^T , B^T and

verify that $(AB)^T = B^T A^T$.

(f) Find all solution of the equation $x^3 = 2x + 1$.

(g) Consider the parallelepiped with sides $a = j + k$, $b = 2i + j + 3k$ and $c = i + j + 2k$.

i. Find the volume.

ii. Find the area of the face determined by b and c .

2. (a) Plot the graph of the function $f(x) = \begin{cases} 1 - x^2, & \text{if } x < 1 \\ \frac{1}{x}, & \text{if } x \geq 1 \end{cases}$, and indicate where the function is discontinuous.

(b) Find the equation of the tangent line to the curve $y = \frac{1-x}{1+x}$ at the point $(2, -1/3)$ and the sketch the graph of the tangent line.

(c) Plot the graph showing the region under the curve $y = x^4$ from $x = -1$ to $x = 1$ and then find the area of the region.

(d) Plot the polar curve represented by $r = 2$ when

i. $0 \leq \theta \leq \pi$,

ii. $-\pi/4 \leq \theta \leq \pi/4$,

iii. $-2\pi \leq \theta \leq 2\pi$,

where $r = \sqrt{x^2 + y^2}$.

(e) Find all the critical numbers for the function $f(x) = x^{4/5}(x - 4)^2$.

(f) Consider the sequence $\left\{ (-1)^{n-1} \frac{n+2}{5^n} \right\}_{n=1}^{\infty}$.

i. List the first 7 terms of the sequence.

ii. Determine whether the sequence converges.

iii. Find the sum of the first 7 terms of the sequence.

iv. Find the sum of the first n terms of the sequence.

v. Find the sum of the entire sequence (from 1 to ∞).

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3. (a) Find the area of the surface generated by rotating the curve $y = e^x$, $0 \leq x \leq 1$, about the y axis.

(b) Suppose a curve C is defined by the parametric equation $x = t^2$, $y = t^3 - 3t$.

i. Plot the curve.

ii. Find the equation(s) of the tangent line(s) to the curve at the point $(3, 0)$.

iii. Plot the tangent line(s) at the point $(3, 0)$.

(c) Use mathematica to find the general solution of the logistic equation

$$\frac{dy(t)}{dt} = (r - ay(t))y(t).$$

i. Approximate the population using $r = 0.03$, $a = 0.0001$, and $y(0) = 5.3$.

ii. Investigate the behavior of the solution when the initial population is varied.