Total number of printed pages–12

3 (Sem–3/CBCS) MAT SE 1/SE 2

2021

(Held in 2022)

MATHEMATICS

(Skill Enhancement Course)

Paper : MAT–SE–3014

(Computer Algebra Systems and Related Software)

Full Marks : 50

Time : Two hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×4=4

   (a) What is a computer algebra system ?

   (b) Write the Mathematica and Mapple commands to calculate π up to 100 decimals.

Contd.

(c) Write *any two* computer algebra systems' commands to calculate $\sum_{i=1}^{5} i^2$.

(d) Write *any one* computer algebra system expression to calculate the dot product of two vectors (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4).

2. Answer the following questions : 2×3=6

(a) What are the roles of the keyboard keys ENTER and SHIFT + ENTER in Mathematica and Mapple softwares ?

(b) What is the utility of 'Clear' command in Mathematica ? Write a command in Maxima which works similar to 'Clear' command of Mathematica.

(c) In Mathematica notebook, write the procedure to delete all outputs at a time. How can you evaluate all inputs at a time ?

3. Answer ***any two*** parts : 5×2=10

(a) Write the output of the following built-in functions' values in Mathematica :

(i) Binomial[7, 2]

(ii) FactorInteger [625]

(iii) Prime [5]

(iv) D [*sin* [*x*], *x*]

(v) Power [Power [3, 2], 2]

(b) Suppose $f(x) = x^3 + \sin x$. In *any two* computer algebra systems, define the function suitably and write the input statements $f(\pi)$. Write the commands in those systems to calculate the differentiation of the said function.

(c) Explain with examples, two different ways to define a piecewise function in Mathematica.

(d) Write a program in Maxima using user-defined function to find the square root of 81 with the help of Newton's method.

4. Answer **any three** parts : 10×3=30

(a) (i) Let $A = (a_{ij})_{3\times 3}$ be a matrix. Write the commands in Mathematica to extract the diagonal elements from the matrix and obtain the adjoint of A. Hence write the commands to find inverse of A, without using the Mathematica command 'Inverse[A]'. 5

(ii) Write the Mathematica program to solve the system $AX = 0$, where, A is the 3×3 coefficient matrix, X is the 3×1 matrix containing the variables x, y, z. 0 is the 3×1 zero matrix. 5

(b) Let $v_1 = (10, 4, 5)$, $v_2 = (4, 4, 7)$, $v_3 = (8, 1, 0)$, $b = (1, 2, 3)$ be four vectors in R^3. Write a Mathematica program to check whether b is a linear combination of the vectors v_1, v_2, v_3 or not. Write the possible outputs of each command from the program. Also check whether v_1, v_2, v_3 are linearly independent or not. Discuss your conclusion from the program output.

(c) Gram-Schmidt process of orthogonalization for the vectors $v_1, v_2, \ldots, v_n \in R^n$ is

$$u_1 = v_1,\ u_k = v_k - \sum_{i=1}^{k-1} \frac{< v_k, u_i > u_i}{< u_i, u_i >},\ k = 2, 3, \ldots, n$$

$< a, b >$ represents dot product of a and b. Further Gram-Schmidt orthonormal set is $\left\{ \frac{u_1}{|u_1|}, \frac{u_2}{|u_2|}, \frac{u_n}{|u_n|}, \ldots, \frac{u_1}{|u_1|} \right\}$.

Let $v_1 = (10, 4, 5)$, $v_2 = (4, 4, 7)$, $v_3 = (8, 1, 0)$ be three vectors. Write the Mathematica command to obtain the Gram-Schmidt orthonormal set. Without using that command, write suitable Mathematica expressions to obtain the Gram-Schmidt orthonormal set from the vectors v_1, v_2, v_3. Write the output of each step. How can you verify, in Mathematica, whether the set is orthonormal or not?

(d) Write a short note on Mapple as calculator. Give examples.

(e) Write a short note on built-in function and user-defined functions in Maxima Give examples.

(f) Write the commands in Mathematica Mapple and Maxima for the following problems :

(i) Plotting $y = \sin x, 0 \leq x \leq 2\pi$;

(ii) Showing a graph of three lines, $y = 4x + 1, y = -x + 4,$ and $y = 9x - 8$, for $0 \leq x \leq 2$;

(iii) Showing a graph of the surface $z = e^{-x^2+y^2}, -2 \leq x, y \leq 2.$