MADHAVA MATHEMATICS COMPETITION

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and

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$$4\left(\sum_{k=1}^{n}\frac{(-1)^{k-1}}{2k-1}+(-1)^{n}\frac{n^2+1}{4n^3+5n}\right)$$

3.14159265358...

This is to certify that

Champeshwar Kumar

of **S.Y. B.Sc.**

from **Maharshi Vedvyas Govt. P.G. College Bhakhara**

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held on January 29, 2023.

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Gulshan Kumar

of **S.Y. B.Sc.**

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Yugalkishor

of **S.Y. B.Sc.**

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Mukesh

of **S.Y. B.Sc.**

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Tameshwar

of **S.Y. B.Sc.**

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Gagan Kumar

of **F.Y. B.Sc.**

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Dulari

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Shalani

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Manish Sen

of **F.Y. B.Sc.**

from **Maharshi Vedvyas Govt. P.G. College Bhakhara**

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Vikash

of **F.Y. B.Sc.**

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Usha

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Kavita

of **F.Y. B.Sc.**

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Hemlata Sahu

of **F.Y. B.Sc.**

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Prashant Kumar

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Satish Kumar

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Bhamashah

of **F.Y. B.Sc.**

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Sakshi Sahu

of **F.Y. B.Sc.**

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Vaishnavi

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Vidya

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जिला–धमतरी (छ.ग.)
E-mail Id- gcbhakhara@yahoo.com, Website- www.govtcollegebhakhara.in

Special Cde
1505

दिनांक :– 28.01.2023

परीक्षा सूचना

Madhava Mathematics Competition परीक्षा के लिये पंजीकृत बी.एस.सी. प्रथम वर्ष एवं बी.एस.सी. द्वितीय वर्ष गणित के विद्यार्थियों को सूचित किया जाता है कि उक्त परीक्षा दिनांक 29.01.2023 दिन रविवार को समय 11:30 बजे आयोजित किया जावेगा। उपरोक्त हेतु परीक्षार्थी निर्धारित समय से आधा घंटा पूर्व परीक्षा केन्द्र मे उपस्थिति देवें।

परीक्षा का नाम – Madhava Mathematics Competition Exam
परीक्षा केन्द्र – महर्षि वेद व्यास शास. स्नात. महा. भखारा
परीक्षार्थियों की संख्या – 20

परीक्षा प्रभारी

प्राचार्य
महर्षि वेद व्यास शास. स्नात. महा. भखारा
जिला धमतरी (छ.ग.)

MADHAVA MATHEMATICS COMPETITION
(A Mathematics Competition for Undergraduate Students)
Organized by
Department of Mathematics, S. P. College, Pune (Autonomous)
and
Homi Bhabha Centre for Science Education, T.I.F.R., Mumbai

Date: 29/01/2023 Max. Marks: 100
Time: 12.00 noon to 3.00 p.m.
N.B.: Part I carries 20 marks, Part II carries 30 marks and Part III carries 50 marks.

Part I

N.B. Each question in Part I carries 2 marks.

1. The number of positive divisors of $2^{24} - 1$ is
   (A) 192 (B) 48 (C) 96 (D) 24.

2. The equation $\text{Re}\,(z^2) = 0$ represents
   (A) a circle (B) a pair of straight lines (C) an ellipse (D) a parabola.

3. If $A = \begin{pmatrix} \alpha & 2 \\ 2 & \alpha \end{pmatrix}$ and $\det A^3 = 125$, then the values of α are
   (A) ± 1 (B) ± 2 (C) ± 3 (D) ± 5.

4. Let A, B, C be three non-collinear points in a plane. The number of points at a distance 1 from A, 2 from B and 3 from C is
   (A) exactly 1 (B) at most 1 (C) at most 2 (D) always 0.

5. Let $A = \{x \in [-2, 3] : \cos x > 0\}$. Then
   (A) $\inf A = 0$ (B) $\sup A = \pi$ (C) $\inf A = -\pi/2$ (D) $\sup A = 3$.

6. Let $\{a_n\}$ be a sequence of real numbers such that $|a_{n+1} - a_n| \leq \dfrac{2023}{n}|a_n - a_{n-1}|$, $\forall n$. Then the sequence $\{a_n\}$ is
   (A) not Cauchy (B) Cauchy but not convergent (C) convergent (D) not bounded.

7. Let $f : \mathbb{R} \to \mathbb{R}$ be a continuous function and F be a primitive of f (i.e. $F' = f$). If $3x^2 F(x) = f(x)$ for all $x \in \mathbb{R}$ then $f(x) =$
   (A) e^{x^3} (B) $3x^2 e^{x^3}$ (C) $x^2 e^{x^2}$ (D) $3xe^{x^3}$.

8. $1 \times 2 - 2 \times 3 + 3 \times 4 - 4 \times 5 + \cdots - (2022) \times (2023) =$
   (A) $(-2)(1011)(1012)$ (B) $-(1011)(1012)$
   (C) $(-4)(1011)(1012)$ (D) $2(1011)(1012)$.

9. The number of times the digit 7 is written while listing all integers from 1 to $1,00,000$ is
   (A) 10^4 (B) $5(10)^4 - 1$ (C) 10^5 (D) $5(10)^4$.

10. The differential equation $y'^2 - (x + \sin x)y' + x \sin x = 0$, with $y(0) = 0$ has
    (A) unique solution (B) two solutions (C) no solution (D) four solutions.

Part II

N.B. Each question in Part II carries 6 marks.

1. Consider $f(x) = x[x^2]$, where $[x^2]$ is the greatest integer less than or equal to x^2. Find the area of the region above X-axis and below $f(x)$, $1 \leq x \leq 10$.

2. In how many ways can numbers from 1 to 100 be arranged in a circle such that sum of pair of integers placed opposite each other is the same? (arrangements are equivalent up to rotation).

3. Find all triplets (x, y, z) of integers satisfying $x^2 + y^2 + z^2 = 16(x + y + z)$.

4. Suppose A is a singular matrix of order 3 with complex entries all of which having absolute value 1. Show that two rows or two columns of the matrix A are proportional.

5. Let $f : \mathbb{R} \to \mathbb{R}$ be a continuous function satisfying $f^3(x) = x$. Prove that $f^2(x) = x$.

Part III

[12]

1. Find

   (a) $\lim_{n\to\infty} \dfrac{\gcd(1,6) + \gcd(2,6) + \cdots + \gcd(n,6)}{1 + 2 + \cdots + n}$;

   (b) $\lim_{n\to\infty} \dfrac{lcm(1,6) + lcm(2,6) + \cdots + lcm(n,6)}{1 + 2 + \cdots + n}$.

[12]

2. Let a, b, c be real numbers such that $a^2 + b^2 + c^2 = 4$.

   (a) Find the value of the determinant of a matrix $A = \begin{pmatrix} a+b & b+c & c+a \\ b+c & c+a & a+b \\ c+a & a+b & b+c \end{pmatrix}$.

   (b) Find the maximum and minimum value of the above determinant.

3. For every $t \in \mathbb{R}$, let L_t be the line segment joining $(0, 1)$ with $(t, 0)$. Suppose L_t intersects the parabola $y = x^2$ at the point P_t. Define $f : \mathbb{R} \to \mathbb{R}$ as $f(t) = y$-coordinate of P_t. Answer the following questions with justification: [13]

   (a) Is f continuous?

   (b) Is f bounded?

   (c) What is $\lim_{t\to\infty} f(t)$?

   (d) Is f differentiable at 0?

4. The sequence $\{q_n(x)\}$ of polynomials is defined by $q_1(x) = 1 + x$, $q_2(x) = 1 + 2x$ and for $m \geq 1$ by

$$q_{2m+1}(x) = q_{2m}(x) + (m+1)xq_{2m-1}(x),$$
$$q_{2m+2}(x) = q_{2m+1}(x) + (m+1)xq_{2m}(x).$$

   [13]

   Let x_n be the largest real solution of $q_n(x) = 0$. Prove that

   (a) the sequence $\{x_n\}$ is increasing.

   (b) $x_{2m+2} > \dfrac{-1}{m+1}$ for $m \geq 1$.

   (c) the sequence $\{x_n\}$ converges to 0.

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Registration Form for Participating Colleges

To,
The Chief Coordinator,
Prof. V. M. Sholapurkar
Professor and Head,
Center for Postgraduate Studies in Mathematics,
S. P. College, Pune 411030.

Name of the College - Maharshi Vedvyas Govt. P.G. College Bhakhara
Address- Bhakhara
District: Dhamtari Office Phone No. (STD) Mob.:
Name of the contact person - Mr. Janendra Banjare Mob.9165882369
Email-ID of the contact person - janendraalgebra11@gmail.com

Sr. No.	Name of Student	Father's Name	Class (F.Y./S.Y./T.Y. B.Sc)	D.O.B.
1	Vidya	Mr. Mahendra Puri	B.Sc. - I	06-04-2005
2	Vaishnavi	Mr. Narayan Dhruwanshi	B.Sc. - I	11-05-2005
3	Sakshi Sahu	Mr. Narayan Das Sahu	B.Sc. - I	20-08-2005
4	Bhamashah	Mr. Leeladhar	B.Sc. - I	01-03-2004
5	Satish Kumar	Mr. Sukalu	B.Sc. - I	03-06-2004
6	Prashant Kumar	Mr. Yashwant Kumar	B.Sc. - I	22-07-2004
7	Girdhar Lal	Mr. Khamhan Lal	B.Sc. - I	02-05-2005
8	Hemlata Sahu	Mr. Mohan Lal	B.Sc. - I	29-12-2004
9	Kavita	Mr.Khamhan Lal Sahu	B.Sc. - I	29-02-2004
10	Usha	Mr. Cheshwar	B.Sc. - I	15-06-2004
11	Vikash	Mr. Narsingh	B.Sc. - I	25-01-2005
12	Manish Sen	Mr. Domanlal Sen	B.Sc. - I	19-04-2005
13	Shalani	Mr. Narayan Sahu	B.Sc. - I	28-12-2004
14	Dulari	Mr. Chandrahas Dewangan	B.Sc. - I	15-08-2003
15	Gagan Kumar	Mr. Shiv Kumar Sahu	B.Sc. - I	23-01-2004
16	Tameshwar	Mr. Chandrahas	B.Sc.- II	12-06-2003
17	Mukesh	Mr. Dauwa	B.Sc.- II	26-08-2003
18	Yugalkishor	Mr. Purshottam	B.Sc.- II	09-05-2003
19	Champeshwar Kumar	Mr. Mahendra Kumar	B.Sc.- II	27-02-2002
20	Gulshan Kumar	Mr. Bhojram	B.Sc.- II	23-08-2002

Co-ordinator

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