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Structural obstacle eighth order problem: Magnificent synthesis appraisal over advanced approach

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Abstract

Bridge issues are challenging. Higher-order problems frequently call for sophisticated mathematical methods such as partial differential equations, functional analysis, and calculus of variations. These strategies might be used to create analytical or numerical methods for estimating the answers to these complex problems. There are several ways to settle disputes with bridges. Among the numerous methods that already exist, a fresh strategy was developed. This research uses a Novel technique to resolve bridge-related problems. This approach may be used to handle various static and dynamic issues. This method's main advantage is that it provides solutions more rapidly and precisely than other methods. The current research considered and addressed Eighth-order bridge problems using this strategy. It uses a basic supported continuous beam with n supports and different loading scenarios. Two groups of bridges with different lengths were specifically assessed. Before being resolved using various strategies, the entire length of the beam was expected to oscillate between -1 and 1 in the first case and between 0 and 1 in the second example. To tackle any space-related issue, boundary conditions were taken into account. Based on the findings of this technique, it is evident that the results of the special method approach are amassing swiftly and getting close to the correct solution in terms of space. The result of this process is then contrasted with the precise response, and it is found that they are very similar. For academic reasons and in numerous technical sectors, the current research will help resolve any issues with this method.

Keywords: Bridge; Eighth-order; Novel technique; Mathematical models; Continuous beam

1. Introduction

The process entails breaking down the nonlinear problem into smaller linear equations that may be solved repeatedly. The Novel polynomials, a collection of recursive polynomials that can approximate the solution of a nonlinear differential equation, are used to compute each term in the series [1]. The Novel approach can be applied to various nonlinear issues, including ones that cannot be resolved using conventional techniques. Additionally, it enables the computation of analytical solutions, which can give more information on how the system under study behaves [2,3]. The method successfully solves complicated issues with high precision and incorporates techniques from various domains, including physics, engineering, and finance. Nonlinear ordinary differential problems (ODEs) and partial differential equations (PDEs) may both be solved effectively using the innovative approach [4,5].

The process entails applying the nonlinear operation of the differential equation to the response itself in order to create a set of functions known as Novel polynomials. The approach offers a number of benefits over other numerical methods for solving ODEs, including some of the following: Nonlinear issues Since there is no need to linearize or simplify the

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problem, the Novel technique is advantageous for solving nonlinear ODEs. Because of this, it may be used for many applications involving nonlinear equations that govern [6]. (b) Convergence: It has been demonstrated that the approach will converge to the precise solution of the ODE if the nonlinear operator meets certain requirements and the solution is adequately smooth [7]. (c) Analytical expression: The methodology offers an analytical expression for the solution of the Adomian polynomial, which is simple to evaluate using common numerical methods [8]. (d) Effectiveness: Using common programming languages, the Novel technique is computationally effective and simple to implement on a computer [9,10]. (e) Flexibility: The approach may easily handle various boundary requirements, beginning conditions, and other limitations frequently encountered in actual applications. There is no requirement for linearization or perturbation procedures since a novel methodology may be employed to solve nonlinear PDEs [11,12] directly. Since conventional analytical techniques cannot handle highly nonlinear problems, the approach is particularly helpful in these situations. A simple implement Novel approach is an easy-to-use technique that may be used with different nonlinear PDEs. A non-iterative strategy, such as a new approach, yields the answer in a single step. The approach is significantly quicker as a result than iterative techniques like the finite element or finite difference methods [13,14]. A unique methodology can generate extremely accurate solutions to nonlinear PDEs compared to numerical techniques like finite element or finite difference methods. For the purpose of solving differential equations, the novel is a potent analytical tool [15,16]. In order to solve a nonlinear differential equation repeatedly, a sequence of easier equations must first be broken down into it. Although the Novel approach has shown to be an efficient technique for tackling many issues, it can occasionally run into real-world issues that need for unique solutions. Here are a few typical real-world issues with the Novel method and their fixes. Issues with convergence for some nonlinear differential equations, a novel technique might not converge. Selecting the decomposition operator is challenging. It might be difficult to select the best one [17]. One approach to solving this issue is using many decomposition operators and comparing the outcomes to choose the optimal one. The novel technique might not be able to handle boundary circumstances with nonlinear functions [18]. One possible option is utilizing perturbation techniques to linearize the boundary conditions in this situation. beginning conditions that are nonlinear: A novel technique may have trouble managing nonlinear beginning conditions. One potential answer is utilizing a linearization technique to transform the starting circumstances into a linear form that can be quickly solved using a novel approach [19]. High computational complexity: Novel approaches might necessitate a lot of iterations, which could lead to high computational complexity. Utilizing parallel processing or other high-performance computing methods to cut down on computation time is one way to solve this issue [20]. Overall, solving nonlinear differential equations using the Novel approach is a valuable analytical method. However, the possible practical issues that can occur and the precise remedies that might be used to solve them are crucial. The objective is to statistically address beginning and boundary problems using a novel technological approach. Understanding how such reactions differ from precise answers is essential [21]. Also provided are some general changes and instructions for such precise responses. The finite element model must be used for various issues, and its dependability under different conditions must be examined [22].

This paper presents a novel technique for solving an eighth-order boundary assessment problem. Deliberate the subsequent eighth-order boundary-value problems:

$$u^{(8)}(x) + \varphi(x)u(x) = \psi(x),\ a \le x \le b \quad \ldots\ldots\ldots\ldots\ldots\ (1)$$

Boundary provisions: $u(a) = A_{00}$, $u^{(2)}(a) = A_{22}$, $u^{(4)}(a) = A_{44}$, $u^{(6)}(a) = A_{66}$,

$$u(b) = B_{00},\ u^{(2)}(b) = B_{22},\ u^{(4)}(b) = B_{44},\ U^{(6)}(b) = B_{66}$$

$$u^{(8)} = e^{-x}u^2(x),\ 0 \le x \le 1 \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Boundary situations: $u(0) = u^{(2)}(0) = u^{(4)}(0) = U^{(6)}(0) = 1$, $u(1) = u^{(2)}(1) = u^{(4)}(1) = u^{(6)}(1) = e$

2. Methodology

Demonstrate NOVEL METHOD, reflect the ensuing nonlinear differential reckoning: $A(u) - f(r) = 0$, $r \in \Omega$, (2) with boundary circumstances:

$$B(u, \partial u/\partial n) = 0,\ r \in \Gamma,\ ,\ldots\ldots\ldots\ldots\ldots\ (3)$$

Here A is a general differential operator, B is a limit operator, f(r) is an identified analytic function, and Γ is the limit of the domain Ω.

Consequently, Eq. (2) can be rephrased as follows: $F(u) + N(u) - f(r) = 0$.

Erected a homotopy: $\Omega \times [0,1] \rightarrow R$ contents:

$$H(\upsilon, p) = (1-p)[F(\upsilon) - F(\upsilon_0)] + p[A(\upsilon) - f(r)] = 0, \quad \ldots\ldots\ldots \quad (4)$$

$$H(\upsilon, p) = F(\upsilon) - F(\upsilon_0) + pF(\upsilon_0) + p[N(\upsilon) - f(r)] = 0, \quad \ldots\ldots\ldots \quad (5)$$

$$H(\upsilon, 0) = F(\upsilon) - F(\upsilon_0) = 0, H(\upsilon, 1) = A(\upsilon) - f(r) = 0, \quad \ldots\ldots\ldots \quad (6)$$

Assume that the solution of (4) or (5) can be expressed as a series in p, as follows:

$$\upsilon = \upsilon_0 + p\upsilon_1 + p^2\upsilon_2 + p^3\upsilon_3 + \ldots, \ldots\ldots\ldots\ldots\ldots \quad (7)$$

when p→1, (4), or (5) corresponds to (3) and becomes the approximate solution of (3), i.e.,

$$u = \lim_{p \to 1} \upsilon = \upsilon_0 + \upsilon_1 + \upsilon_2 + \upsilon_3 + \ldots \ldots\ldots\ldots\ldots\ldots \quad (8)$$

2.1. Problem statements

This segment presents five examples to show the competence and high accurateness of the present method.

The analytic elucidation, u(x), is represented by E_∞ and can be intended by:

$$E_\infty = \text{Maximum}\ \{|u(x) - \Phi_1(x)|, t \in [a, b]\}.$$

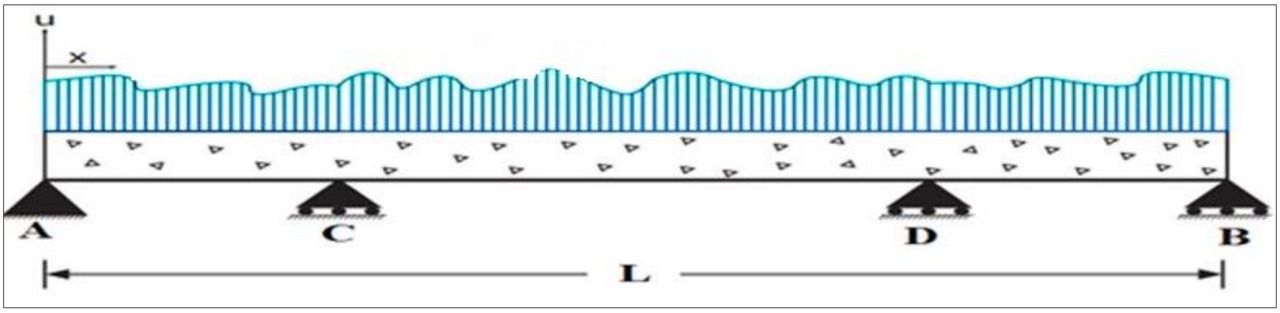

Figure 1 Beam with Disparate Loading

Fig. 1 depicts the obstacle bridge having disparate loading functions for different problems considered in this pape

3. Results and discussion

3.1. Obstacle bridge problem 1

Consider (1) with $\varphi(x) = x, \psi(x) = -(48 + 15x + x^3)e^x$ varies from [0,1]

Boundary provisions:

$A_{00} = 0, A_{22} = 0, A_{44} = -8, A_{66} = -24$

$$B_{00} = 0, B_{22} = -4e, B_{44} = -16e, B_{66} = -\ldots\ldots\ldots\ (14)$$

$u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$

$$u(x) - \theta(x) - pL_{8x}^{-1}(-(48 + 15x + x^3)e^x - xu) = 0 \ldots\ldots (15)$$

Relieving (7) hooked on (15) and associating the relations with identical powers of p,

$$p^0 : \upsilon_0(x) = \theta(x) \Longrightarrow u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$$

$$p^0 : \upsilon_0(x) = \theta(x) \Longrightarrow u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$$

$$p^1 : \upsilon_1(x,t) = L_{8x}^{-1}(-(48 + 15x + x^3)e^x - xu_0)$$

$$\upsilon_1(x,t) = 792(e^x - 1) - (231e^x + (561)x + (24e^x - 189)x^2 - (e^x 39.5)x^3 - 5.5x^4 - 0.475x^5$$

$$-0.0083x^6 + 0.0053x^7 - 2.83 \times 10^{-6}x^9 a - 5.51 \times 10^{-7}x^{10} b - 1.50 \times 10^{-7}x^{11} c$$

$$-5 \times 10^{-8}x^{12} d - 2 \times 10^{-8}x^{13} k - 9 \times 10^{-8}x^{14} f - 3.8 \times 10^{-9}x^{15} g - 1.92 \times 10^{-9}x^{16} h$$

$$a = 0, b = 0.999, c = 0, d = -0.4992, k = -0.333, f = -0.1250, g = -0.0333 \text{ and } h = -0.0069$$

$$\begin{aligned}\upsilon_1(x) = 792(e^x - 1) - (231e^x + 561)x + (24e^x - 189)x^2 - (e^x + 39.5)x^3 - 5.5x^4 - 0.475x^5 - 0.0083x^6 \\ + 0.0053x^7 - 5.51 \times 10^{-7}x^{10} + 5.01 \times 10^{-8}x^{12} + 6.42 \times 10^{-9}x^{13} + 1.03 \times 10^{-8}x^{14} \\ + 1.284 \times 10^{-10}x^{15} + 1.33 \times 10^{-11}x^{16}\end{aligned}$$

$$\begin{aligned}p^2 : \upsilon_2(x,t) = {} & L_{8x}^{-1}(-(48 + 15x + x^3)e^x - xu_1) \\ = {} & 48960(e^x - 1) - (12783e^x + 36177)x + (1263e^x - 12960)x^2 - (57e^x - 2974.4)x^3 \\ & + (e^x - 485)x^4 - 58.375x^5 - 5.1x^6 - 0.2767857143x^7 + 0.0021825396x^9 + 0.0003091931x^{10} \\ & + 0.0000284090x^{11} + 0.0000019791x^{12} + 0.0000001059x^{13} + 0.0000000039x^{14} + 0(x^{15}).\end{aligned}$$

The elucidation in a closed form by $(x - x^2)e^x$. The $\Phi_1 = \upsilon_0(x) + \upsilon_1(x)$

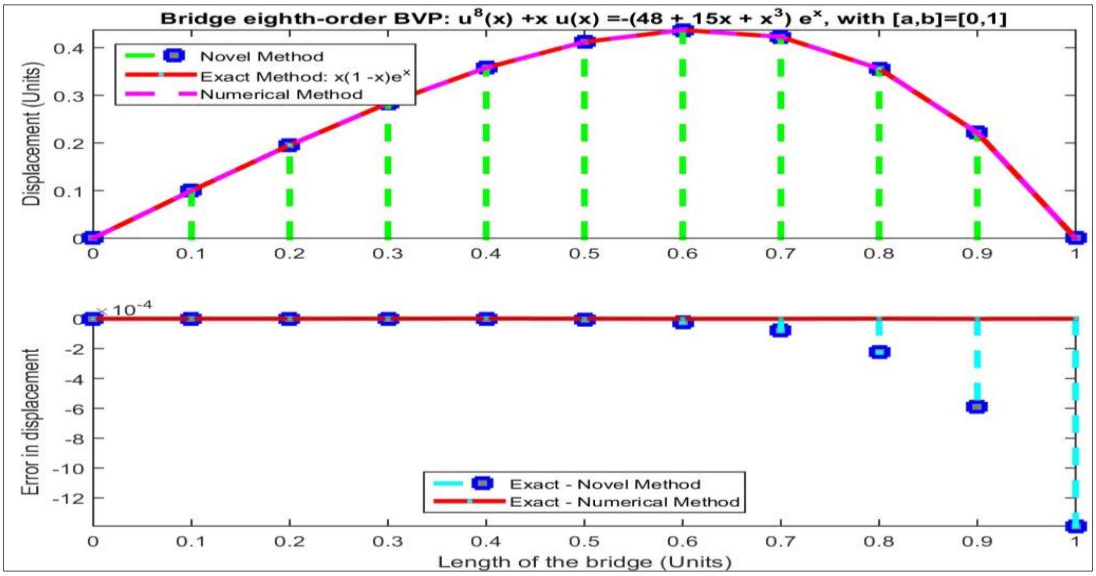

Figure 2 Obstacle Bridge Problem 1 Solution Novel Technique Comparison with Closed-Form & Numerical (FDM) with Their Errors

3.2. Discussion of Results for Problem 1

The response is shown in Fig. 2, Comparing a novel method to numerical and closed-form (VIM) errors. At 0 units, the displacement is 0, and it increases parabolically up to 1 unit, with the most significant value being 0.5 units away at 0.6 units. For a novel and numerical approach, the error plot is drawn. The largest value measured at 1 unit is 12×10^{-4} units. The error is 0 at 0 unit, constant up to 0.6 unit, then increases exponentially to 1 unit. The novel's displacement and error plot figures and numerical methods are almost identical.

3.3. Obstacle bridge problem 2

Consider (1) with $\varphi(x) = -x, \psi(x) = -(55 + 17x + x^2 - x^3)e^x$ varies from $[-1,1]$

$A_{00} = 0, A_{22} = 2/e, A_{44} = -4/e, A_{66} = -18/e,$

$$B_{00} = 0, B_{22} = -6e, B_{44} = -20e, B_{66} = -42e \text{ .... } \quad (16)$$

$$u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7 \quad \text{...... } (17)$$

$$u(x) - \theta(x) - pL_{8x}^{-1}\left(-(55 + 17x + x^2 - x^3)e^x + xu\right) = 0 \ldots\ldots.. (18)$$

Relieving (7) hooked on (18) and likening the relations with identical powers of p,

$$p^0 : \upsilon_0(x) = h(x) \Rightarrow \upsilon_0(x = a + bx + cx^2) + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$$

$$\upsilon_1(x,t) = 711(1 - e^x) - (215e^x + (496)x + (165 - 25e^x)x^2 + (e^x + 35)x^3 + 7.1x^4 + 0.63$$

$$x^5 - 0.07\, x^6 + 0.0091x^7 - 2.75 \times 10^{-6}x^9a - 5.51 \times 10^{-7}x^{10}b - 1.50 \times 10^{-7}x^{11}c$$

$$-5 \times 10^{-7}x^{12}d - 1.92 \times 10^{-8}x^{13}k - 8 \times 10^{-8}x^{14}f - 4 \times 10^{-9}x^{15}g - 2 \times 10^{-9}x^{16}h$$

Including the boundary situations (16) hooked on the $v_1(x)$ yields a linear system with 8 reckonings and 8 variable quantities. Resolving this linear system concurrently,

Have $a = 1.000000125$, $b = 1.000000024$, $c = -0.5000001543, d = -0.8333333719, k = -0.4583333, f = -0.1583333, g = -0.0402777798$ and $h = -0.0081349231$.

The first-order guesstimate solution:

$$\upsilon_1(x,t) = 711(1 - e^x) - (215e^x + (496)x + (165 - 25e^x)x^2 + (e^x + 35)x^3 + 7.1x^4 + 0.63$$

$$x^5 - 0.07\, x^6 + 0.0091x^7 - 2.75 \times 10^{-6}x^9a - 5.51 \times 10^{-7}x^{10}b - 1.50 \times 10^{-7}x^{11}c$$

$$-5 \times 10^{-7}x^{12}d - 1.92 \times 10^{-8}x^{13}k - 8 \times 10^{-8}x^{14}f - 4 \times 10^{-9}x^{15}g - 2 \times 10^{-9}x^{16}h$$

$$\Phi_1(x) = 711(1 - e^x) - (215e^x + (496)x + (165.5 - 25e^x)x^2 + (e^x + 35)x^3 + 7.1x^4$$

$$+0.63x^5 - 0.07\, x^6 + 0.0091x^7 + 4.17 \times 10^{-8}x^{12} + 8.83 \times 10^{-9}x^{13} + 1.307 \times 10^{-8}x^{14}$$

$$+1.55 \times 10^{-10}x^{15} + 1.56 \times 10^{-11}x^{16}$$

$$p^2 : \upsilon_2(x,t) = L_{8x}^{-1}(-(55 + 17x + x^2 - x^3)e^x - xv_1)$$

$$= 46377(e^x - 1) - (1221e^x + 34161)x + (1222e^x - 12194)x^2 - (56e^x - 278)x^3 + (e^x - 452.375)x^4$$
$$- 54.14166664x^5 - 4.695833333x^6 - 0.2517857143x^7 + 0.0019593\, x^9 + 0.0002733686x^{10}$$
$$+ 0.0000248767x^{11} + 0.0000017536x^{12} + 0.0000001019x^{13} + 0.0000000052x^{14} + 0(x^{16}).$$

The elucidation in a closed form $(1 - x^2)e^x$. The $\Phi_1 = \upsilon_0(x) + \upsilon_1(x)$

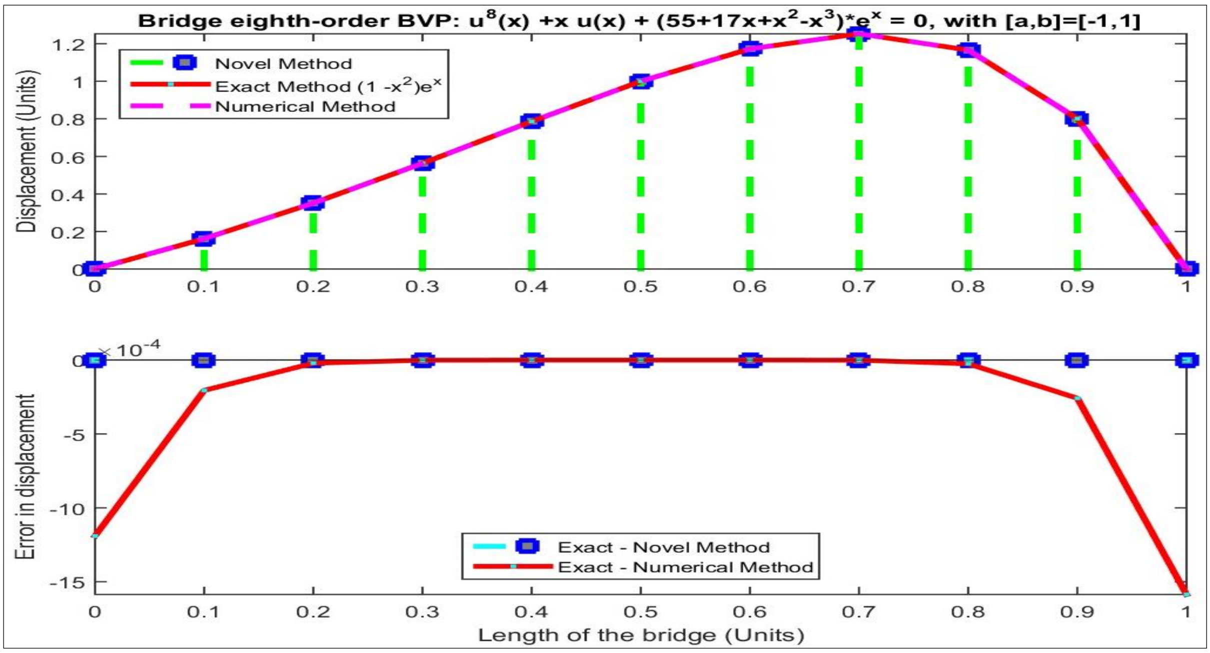

Figure 3 Obstacle Bridge Problem Solution Novel Technique Comparison with Closed-Form & Numerical (FDM) with Their Errors

3.4. Discussion of Results for Problem 2

Fig. 3 shows the outcome of the case. Comparing a novel approach to closed form and numerical (FDM) with their mistakes. The displacement is zero at zero units and varies parabolically up to one unit, with the greatest value being 1.4 displacement at 0.7 units. An error plot is created using a new, numerical approach. The error is 0 at unit 0 and constant up to unit 0.8 before growing exponentially up to unit 1 when the highest value of 15×10^{-4} units is seen. Nearly identical results for the displacement and error plot are shown by both the innovative and numerical methods.

3.5. Obstacle bridge problem 3

Consider (1) with $\varphi(x) = -1, \psi(x) = -8(2x\cos(x) + 7\sin(x))$ varies from $[-1,1]$

$$A_{00} = 0,\ A_{22} = -4\cos(1) - 2\sin(1),\ A_{44} = 8\cos(1) + 12\sin(1),\ A_{66} = -12\cos(1) - 30\sin(1),$$

$$B_{00} = 0,\ B_{22} = 4\cos(1) + 2\sin(1),\ B_{44} = -8\cos(1) - 12\sin(1),\ B_{64} = 12\cos(1) + 30\sin(1) \quad \ldots\ldots\ldots (19)$$

$$u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7 \qquad \ldots\ldots\ldots\ldots\ldots (20)$$

$$u(x) - e(x) - L_{8x}^{-1}(-8(2x\cos(x) + 7\sin(x)) + u) = 0. \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (21)$$

$$p^1 : \upsilon_1(x,t) = L_{8x}^{-1}(-8(2x\cos(x) + 7\sin(x)) + \upsilon_0$$
$$= 72\sin(x) - (16\cos(x) + (56)x + 4x^3 + 0.067x^5 + 0.038\,x^7 - 2.48\times10^{-5}x^8a + 2.75\times10^{-6}x^9b + 5.51\times10^{-7}x^{10}c + 1.50\times10^{-7}x^{11}d - 5.01\times10^{-8}x^{12}k - 1.92\times10^{-8}x^{13}f - 8.25\times10^{-8}x^{14}g - 3.85\times10^{-9}x^{15}h$$

Including the boundary situations (19) hooked on the $v_1(x)$ yields a linear system with 8 reckonings.

$$a = -0.999998, b = 0.000000, c = 1.499998369, d = 0.00000000, k = -0.5416663392,$$

$$f = 0.0000000000, g = 0.0430555332 \text{ and } h = 0.0000000000.$$

$$p^2 : \upsilon_2(x,t) = L_{8x}^{-1}(-(55 + 17x + x^2 - x^3)e^x - xu_1) \Longrightarrow \upsilon_2(x,t) = 272\sin(x) - (240 + 32\cos)) + 29.33333333x^3 - 0.9333333336x^5 + 0.0095238095x^7 - 0.0001543209x^9 + 0.0000006012x^{11} + 0.0000001012x^{13} + 0(x^{15}).$$

The elucidation in a closed form $(x^2 - 1)\sin(x)$. The $\Phi_1 = \upsilon_0(x) + \upsilon_1(x)$

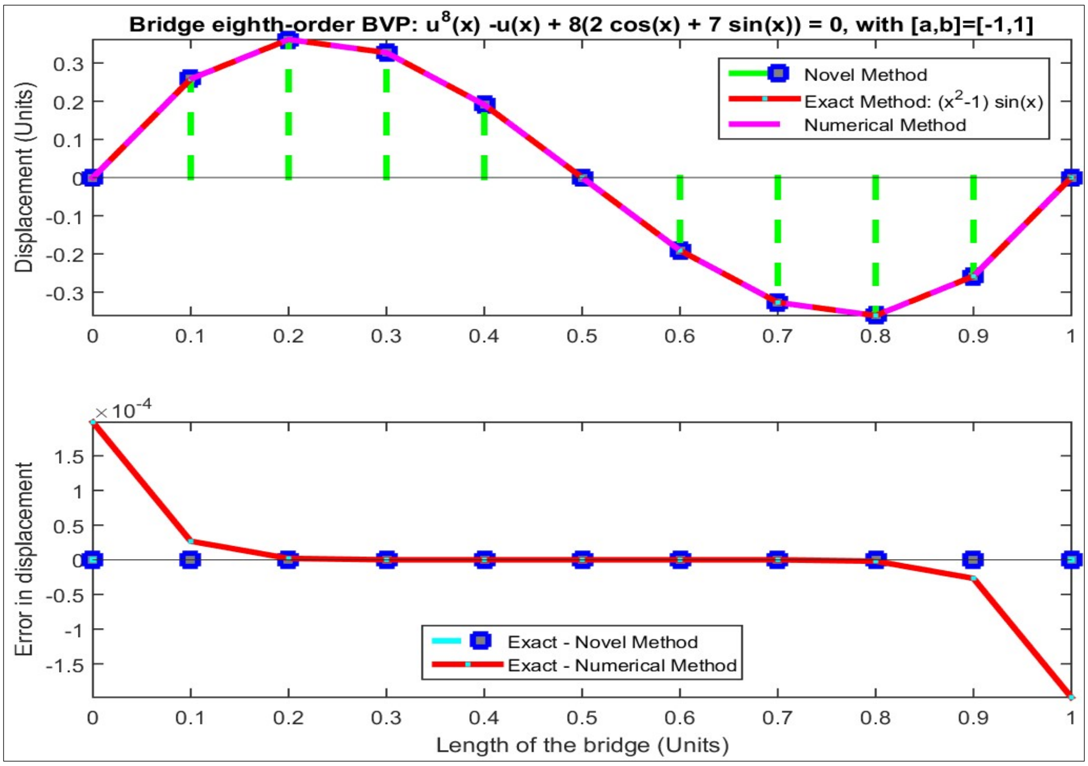

Figure 4 Obstacle Bridge Problem Solution Novel Technique Comparison with Closed-Form & Numerical (VIM) with Their Errors

3.6. Discussion of Results for Problem 3

Fig. 4 depicts the outcome. They are comparing a novel approach to closed form and numerical (VIM) with their mistakes. At 0 units, the displacement is 0, and it increases parabolically up to 1 unit, with the greatest value being 0.4 units at 0.2 units. An error plot is created using a new, numerical approach. The error is 0 at unit 0 and constant up to unit 0.8 before growing exponentially up to unit 1, when the highest value of 1.5×10^{-4} unit is seen. Nearly identical results for the displacement and error plot are shown by both the innovative and numerical methods.

3.7. Obstacle bridge problem 4

Deliberate (1) with $\varphi(x) = -1, \psi(x) = 8(2x\sin(x) - 7\cos(x))$ varies from $[-1,1]$

$$A_0 = 0, A_2 = -4\sin(l) + 2\cos(I), A_4 = 8\sin(l)12\cos(1), A_6 = -12\sin(l) + 30\cos(1)$$

$$B_0 = 0,\ B_2 = -4\sin(l) + 2\cos(I),\ B_4 = 8\sin(l) - 12\cos(1),\ B_6 = -12\sin(l) + 30\cos(1) \text{.............}(22)$$

Relieving (7) hooked on (22) and associating the relations with identical powers of p,

$p^0 : \upsilon_0(x) = h(x) \Longrightarrow \upsilon_0(x = a + bx + cx^2 +) + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$

$$u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7 \text{ .... } (23)$$

$$u(x) - \theta(x) - pL_{8x}^{-1}(8(2x\sin(x) + 7\cos(x)) + u) = 0. \text{ .... } (24)$$

$$p^0 : \upsilon_0(x) = \theta(x) \Longrightarrow \upsilon_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7$$

$$p^1 : \upsilon_1(x,t) = L_{8x}^{-1}(8(2x\sin(x) - 7\cos(x)) + \upsilon_0)$$

$$= 72(\cos(x) - 1) + 16x\sin(x) + 20x^2 - 0.33x^4 + 0.033x^6 - 2.48\times10^{-5}x^8$$

$$+2.75\times10^{-6}x^9b + 5.51\times10^{-7}x^{10}c + 1.50\times10^{-7}x^{11}d - 5.01\times10^{-8}x^{12}k$$

$a = -0.999998, b = 0.000000, c = 1.499998369, d = 0.00000000, k = -0.5416663392,$

$f = 0.0000000000, g = 0.0430555332$ and $h = 0.0000000000.$

$$p^2 : \upsilon_2(x,t) = L_{8x}^{-1}\big(8(2x\sin(x) - 7\cos(x)) + \upsilon_1)\big) = 272(\cos(x) - 1) + (32x\sin(x) + 104x^2$$

$$-6x^4) + 0.1111111111\,x^6 - 0.0017857142x^8 + 0.0000110229x^{10} - 0.0000000167x^{12} - 0.0000000002\,x^{12} + 0(x^{15}).$$

The solution in a closed form $(x^2 - 1)\cos(x)$. The $\Phi_1 = \upsilon_0(x) + \upsilon_1(x)$

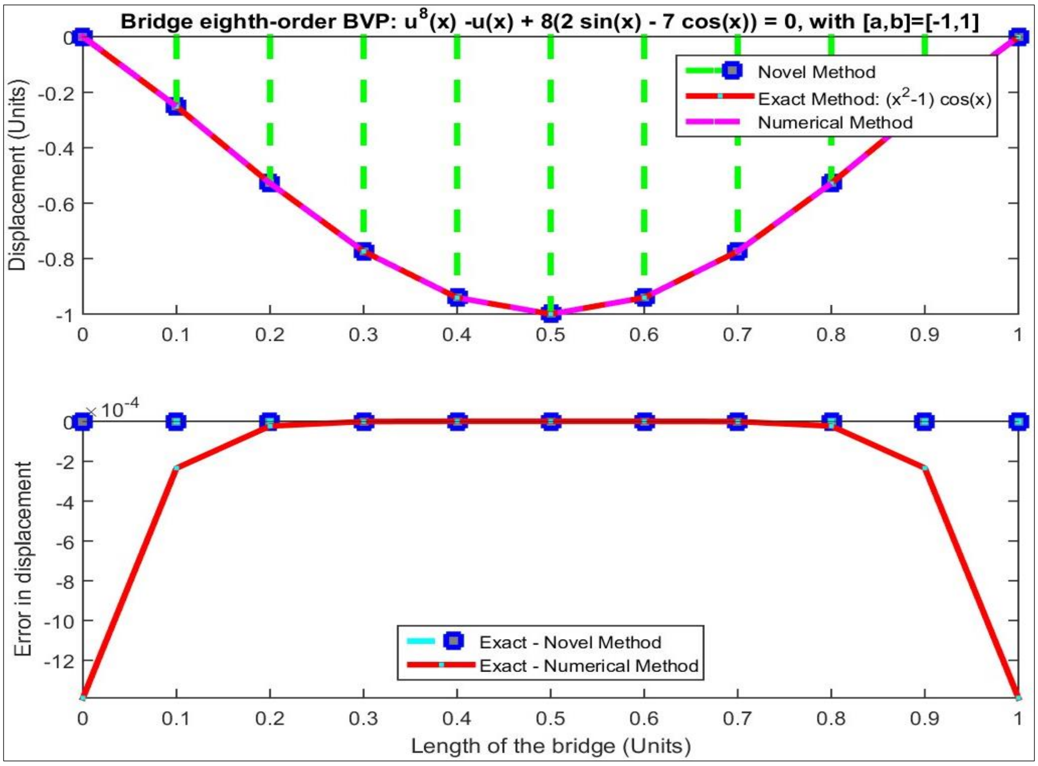

Figure 5 Obstacle Bridge Problem 4 Solution Novel Technique Comparison with Closed-Form & Numerical (VIM) with Their Errors

3.8. Discussion of Results for Problem 4

Fig. 5 shows the outcome of the case. Comparing a novel approach to closed form and numerical (VIM) with its errors. The displacement starts at 0 units and changes parabolically up to 1 unit, reaching its highest value at 0.5 units of length. An error plot is created using a Novel, numerical approach. The error is 0 at unit 0 and constant up to unit 0.8 before growing exponentially up to unit 1, when the highest value of 12×10^{-4} unit is seen. Nearly identical results for the displacement and error plot are shown by both the innovative and numerical methods.

3.9. Obstacle bridge problem 5

Deliberate the nonlinear boundary-value problem.

$$u^{(8)}(x) = e^{-x}u^2(x), 0 \le x \le 1, \text{........} (25)$$

$$u_0(x) = a + bx + cx^2 + dx^3 + kx^4 + fx^5 + gx^6 + hx^7 \text{ ....} (26)$$

$$u(x) - \theta(x) - L_{8x}^{-1}\big(e^{-x}u^2(x)\big) = 0 \text{ ....} (27)$$

$$u(0) = u^{(2)}(0) = u^{(4)}(0) = u^{(6)}(0) = 1, u(1) = u^{(2)}(1) = u^{(4)}(1) = u^{(6)}(1) = e. \qquad \text{..........} (28)$$

$a = 1, b = 1, c = 0.5, d = 0.1666, k = 0.04166, f = 0.008333, g = 0.00138$ and $h = 0.000198$.

$$u_0(x) = 1 + x + 0.5x^2 + 0.1666x^3 + 0.04166x^4 + 0.008333x^5 + 0.00138x^6 + 0.000198x^7.$$

Substituting (7) into (27) and equating the terms with identical powers of p,

$$p^0: u_0(x) = 1 + x + 0.5x^2 + 0.1666x^3 + 0.04166x^4 + 0.0083x^5 + 0.00138x^6 + 0.0001x^7,$$

$$p^1: u_1(x,t) = L_{8x}^{-1}\left(e^{-x}u^2(x)\right) = 8674(e^{-x} - 1) + (e^{-x} + 3031)x + (1785e^{-x})x^2 + 3845e^{-x}x^3$$

$$+(4972e^{-x})x^4 + 613\, e^{-x}x^5 + (55e^{-x})x^6 + (40e^{-x})x^7 + 239e^{-x}x^8 + 11\, e^{-x}x^9$$

$$+0.454\, e^{-x}x^{10} + 0.013\, e^{-x}x^{11} + 0.003\, e^{-x}x^{12} + 0.0049\, e^{-x}x^{13} + 0.006e^{-x}x^{14}.$$

3.10. Discussion of Results for Problem 5

Fig. 6 shows the outcome. Comparing a novel approach to closed form and numerical (VIM) with their errors. The displacement is 0 at 0 units of length, constant up to 0.4 units of length using a new approach, and then slightly over-estimated using a numerical method up to 1 unit of beam length with a maximum displacement value of 10 units. An error plot is created using a new numerical approach. The error is 0 at unit 0 and constant up to unit 0.75 before growing triangularly up to unit 10 when the highest value of 8×10^{-4} unit is seen. Nearly identical results for the displacement and error plot are shown by both the innovative and numerical methods.

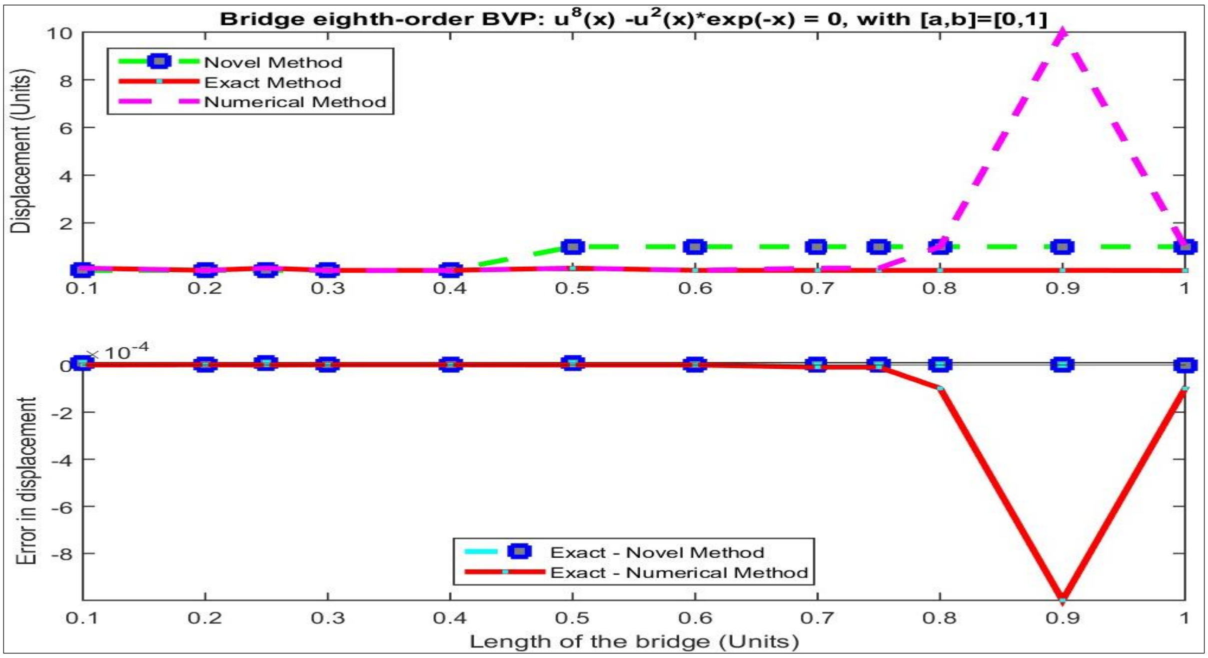

Figure 6 Obstacle Bridge Problem 5 Solution Novel Technique Comparison with Closed Form & Numerical (VIM) with Their Errors

4. Conclusion

A novel method is employed to manage various technical challenges and continuing support bridge challenges. Consequently, the unique technique's results are contrasted with the precise solution. The novel approach is simple to utilize, even for multi-media tasks. The solution is supplied as rapidly converging progressions with easily computable components using the present unique method. In the second order, non-homogeneous Problem, from problems 1 to 5. For problem 1, the maximum displacement and error values recorded were 0.5 and 12×10^{-4} units, respectively. The greatest values for the displacement and error measurements for problem 2 are 1.2 and 15×10^{-4} units, respectively. For scenario 3, the maximum displacement and error values were 0.4 and 1.5×10^{-4} units, respectively. In problem 4, the maximum displacement and error values were observed to be 1 and 12×10^{-4} units, respectively, while in problem 5, the maximum displacement and error values were measured to be 10 and 8×10^{-4} units, respectively. The Novel approach technique's outcomes are assessed using precise responses. It has been proven that this strategy accurately predicts the precise answers to all problems. To show the robustness of various equations, a number of problems have been taken on. In the vast majority of cases, this tactic delivered excellent results.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Ganesh, E., Tiwari, N., Naharla, R., & Ramana, P. V. (2022, December). High-Rise Structure Parametric study to evaluate Cylindrical Charges on Blast Pressures. In ASPS Conference Proceedings (Vol. 1, No. 4, pp. 1159-1164).

[2] Ramana, P. V., Agnihotri, A., Meena, A., Ganesh, E., Shrimali, M. K., & Bharti, S. D. (2022, December). Simulation and Soft Computation on Materials Prognostication Seismic Assessment. In ASPS Conference Proceedings (Vol. 1, No. 6, pp. 1839-1846).

[3] Ganesh, E. (2021). Evaluation of Ground Motion Response Spectra for Coupled Translation and Rotational Tilts. i-Manager's Journal on Civil Engineering, 11(4), 18.

[4] Agnihotri, Anamika, and P. V. Ramana. "GGBS: fly-Ash Evaluation and Mechanical properties within high strength concrete." Materials Today: Proceedings 50 (2022): 2404-2410.

[5] Meena, Ayush, Arigela Surendranath, and P. V. Ramana. "Assessment of mechanical properties and workability for polyethylene terephthalate fiber reinforced concrete." Materials Today: Proceedings 50 (2022): 2307-2314.

[6] Meena, Ayush, Ajay Singh Jethoo, and Ramana PV. "Explosion and Fire Resistance of Recycled Constituent Reinforced Concrete Structures." International Research Journal on Advanced Science Hub 3, no. 5 (2021): 108-115.

[7] Ramana, P. V., and BK Raghu Prasad. "Modified Adomian decomposition method for Van der Pol equations." International Journal of Non-Linear Mechanics 65 (2014): 121-132.

[8] Ramana, P. V., Arigela Surendranath, Anamika Agnihotri, and Kunal Bisht. "Functioning of bi-material interface intended for polypropylene fiber concrete." Materials Today: Proceedings 38 (2021): 3397-3404.

[9] Tiwari, Naveen, Engammagari Ganesh, and P. V. Ramana. "Seismic characterization of symmetrical structure damage and ductility obligation." Materials Today: Proceedings (2023).

[10] Naharla, Rohit, Engammagari Ganesh, and P. V. Ramana. "Seismic effects on reinforced concrete multi-storey structure NDTHA assessment." Materials Today: Proceedings (2023).

[11] Ganesh, Engammagari, Naveen Tiwari, Rohit Naharla, and P. V. Ramana. "Dynamic Analysis for High-Speed Locomotive in Distinct Depths." In ASPS Conference Proceedings, vol. 1, no. 3, pp. 999-1005. 2022.

[12] Ganesh, Engammagari, M. K. Shrimali, and P. V. Ramana. "Higher-order obstacle problems evaluation through novel approach." In ASPS Conference Proceedings, vol. 1, no. 2, pp. 271-278. 2022.

[13] Ganesh, Engammagari, M. K. Shrimali, and P. V. Ramana. "Estimation of Seismic Fragility in Structural Systems." i-Manager's Journal on Structural Engineering 10, no. 2 (2021): 1.

[14] Ganesh, Engammagari, P. V. Ramana, and M. K. Shrimali. "Inelastic materials and mathematical variables for obstacle bridge problem evaluation." Materials Today: Proceedings 65 (2022): 3424-3430.

[15] Ganesh, Engammagari, P. V. Ramana, and M. K. Shrimali. "3D wave problems evaluation and forecasting through an innovative technique." Materials Today: Proceedings 72 (2023): 1175-1180.

[16] Bisht, Kunal, and P. V. Ramana. "Sustainable production of concrete containing discarded beverage glass as fine aggregate." Construction and Building Materials 177 (2018): 116-124.

[17] Raghu Prasad, B. K., and P. V. Ramana. "Modified Adomian decomposition method for fracture of laminated uni-directional composites." Sadhana 37 (2012): 33-57.

[18] Ganesh, Engammagari, P. V. Ramana, and M. K. Shrimali. "Thermo-plastic material durability resistivity evaluation through experimental and analytical tactics." Materials Today: Proceedings 74 (2023): 130-136.

[19] Ganesh, Engammagari, P. V. Ramana, and M. K. Shrimali. "Solved structural dynamic mathematical models via novel technique approach." Materials Today: Proceedings 62 (2022): 3133-3138.

[20] Ganesh, Engammagari, P. V. Ramana, and M. K. Shrimali. "Unsolved structural dynamic mathematical models via Novel technique approach." Materials Today: Proceedings 62 (2022): 684-691.

[21] Meena, Ayush, Ajay Singh Jethoo, and P. V. Ramana. "Impact of blast loading over reinforced concrete without infill structure." Materials Today: Proceedings 46 (2021): 8783-8789.

[22] Li, Wenshan, Zhao Liu, and Fabio Freddi. "Non-smooth dynamic analysis of curved bridges considering the earthquake-induced end-pounding." Engineering Structures 289 (2023): 116320.