**M-Tech in Structural Engineering - First Year (I Semester) Examination**

**Full Title of Paper:** Theory of Elasticity & Plasticity

**Paper Code:** 20PCI101D

**Feb / March - 2022**

**Time:** 3 Hours **Maximum Marks:** 60 SET - **III**

**Instructions to the Students:**

1. Illustrate your answers with neat sketches, diagram etc wherever necessary
2. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly.

| Q. No. | | Question | Marks |
|---|---|---|---|
| Q1 | | **Attempt the following Multiple Choise Questions** | 10 |
| | 1 | Flow stress corresponds to<br>A. Fluids in motion<br>B. Breaking point<br>C. Plastic deformation of solids<br>D. Rupture stress | |
| | 2 | If percentage reduction in area of a certain specimen made of material 'A' under tensile test is 60% and the percentage reduction in area of a specimen with same dimensions made of material 'B' is 40%, then<br>A. The material A is more ductile than material B<br>B. The material B is more ductile than material A<br>C. The ductility of material A and B is equal<br>D. The material A is brittle and material B is ductile | |
| | 3 | In the stress-strain curve, loading and unloading of the material in the elastic region follow the same path.<br>A. True<br>B. False<br>C. Both A & B<br>D. Neither A nor B | |
| | 4 | In the stress-strain curve, loading and unloading of the material in the plastic region follow the same path.<br>A. True<br>B. False<br>C. Both A & B<br>D. Neither A nor B | |
| | 5 | Which of the following strengthening mechanism is most effective in increasing the creep resistance of the material?<br>A. Precipitation hardening<br>B. Strain hardening<br>C. Dispersion strengthening<br>D. Solid solution strengthening | |
| | 6 | What is SI unit of yield strength?<br>A. Newton<br>B. Newton / sq. m.<br>C. Newton sq. m.<br>D. gram / sq. cm. | |
| | 7 | _____ is the maximum stress that can be applied to the material without causing plastic deformation.<br>A. Tensile strength<br>B. Fatigue strength<br>C. Compressive strength<br>D. Yield strength | |

**M-Tech in Structural Engineering - First Year (II Semester) Examination**

**Structural Audit**

**Paper Code:**20PCI204E-C: Elective III

**May / June - 2022**

**Instructions to the Students:**

1. Illustrate your answers with neat sketches, diagram etc wherever necessary
2. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it

| Q. No. | | | Question | Marks |
|---|---|---|---|---|
| Q1 | | | What are the different visual aids used in Visual inspection? Explain any three in detail. | 10 |
| | | | | |
| Q2 | A | | Answer the following questions | |
| | | 1 | Illustrate the steps involved while performing structural audit. | 6 |
| | | 2 | Differentiate between Destructive and Non- Destructive testing. | 6 |
| | B | | Answer the following questions | |
| | | 1 | Explain in detail the purpose and bye-laws of structural auditing. | 8 |
| | | | **OR** | |
| Q3 | A | | Answer the following questions | |
| | | 1 | Write the step by step procedure of rebound hammer test to be performed on the damaged RCC elements. | 6 |
| | | 2 | Explain Principle of Cover Meter and give its Applications and Limitations? | 6 |
| | B | | Answer the following questions | |
| | | 1 | Describe the step by step procedure of ultrasonic pulse velocity test to be performed on the surface of RC elements. | 8 |
| | | | | |
| Q4 | | | Answer the following questions | |
| | | 1 | Write the step by step procedure for the following repair methods i) Gunitting ii) Jacketing. | 6 |
| | | 2 | What are the parameters for assessment for restoration strategies for concrete structures? | 6 |
| | B | | Answer the following questions | |
| | | 1 | Enumerate the different methods available for repairs of concrete works. Discuss any one in detail | 8 |
| | | | **OR** | |
| Q5 | A | | Answer the following questions | |
| | | 1 | Explain the process of Repairs and Rehabilitations of Structures in detail | 6 |
| | | 2 | Write a short note on Demolition of Fire Damaged Building. | 6 |
| | B | | Answer the following questions | |
| | | 1 | What are the Recommendation for Demolition of Certain Special Types and Elements of Structures | 8 |
| | | | | |
| Q6 | | | Answer the following questions | |
| | | 1 | Expalin in detail the Demolition Methods for Buildings and other Structures? | 10 |

****BEST OF LUCK****

**Second Term Exam A. Y. 2021 – 2022 (Jun – Jul 22)**

**Programme Name : M. Tech. (Structural Engineering) 2nd Sem Exam**

Course Code: 20PCI203D
Name of the course: Research Methodology
Max Marks: 60
Duration: 3hrs

Instructions:

(a) Write your answers clearly and legibly.
(b) Statistical test values and table values are provided in the question paper itself. There is no need for any other document for statistical values.
(c) Write precise and to-the-point answers.
(d) Use illustrations and flowcharts where required.

Q.1 Answer **any two**

a. Write a short note on the criteria of good research. 5
b. Write a short note on literature review. 5
c. What are different techniques involved in defining a research problem? 5

Q.2 Answer **any two**

a. What is a statistical distribution? Explain with examples. 5
b. Explain the characteristics of a good sample design. 5
c. Explain the basic principles of experimental design. 5

Q.3 Answer **any two**

a. Explain primary and secondary data, with examples. 5
b. Write short notes on the methods of data collection. 5
c. What is a factorial experiment? 5

Q.4 Answer **any two**

a. What is the need of understanding dispersion and how is it helpful? 5
b. What is regression? Explain with examples. 5
c. What is a cumulative probability distribution? 5

Q.5 Answer **any two**

a. Explain t-test 5
b. Write a short note on the Friedman's test. 5
c. Write a short note on the Spearman's Rank correlation. 5

Q.6 Answer **any two**

a. Write a short note on writing a research proposal. 5
b. Write a short note on summarizing literature. 5
c. Write a short note on the spreadsheet software. 5

**M-Tech in Structural Engineering - First Year (II Semester) Examination**

**Full Title of Paper:** Theory of ~~Elasticity & Plasticity~~ Plates & Shells

**Paper Code:** 20PCI201D

**June / July - 2022**

**SET - III**

**Instructions to the Students:**

1. Illustrate your answers with neat sketches, diagram etc wherever necessary
2. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly.

| Q. No. | | Question | Marks |
|---|---|---|---|
| Q1 | | **Attempt the following Multiple Choise Questions** | 10 |
| | 1 | Equation of deflection forfixed circular plate subjected to uniformally distrubated load is<br>A. W = q /64 D (a2 – r2)<br>B. W = q /64 D (a2 + r2)2<br>C. W = q /64 D (a2 – r2)2<br>D. W = q / D (a2 – r2)2 | |
| | 2 | Equation of deflection for circular plate subjected to center point load<br>A. W = (q r2/8 π D) (log r – 1) + C1 (r2/4) + C2 log r + c3<br>B. W = (q r2/8 π D) (log r + 1) + C1 (r2/4) + C2 log r + c3<br>C. W = (q r2/π D) (log r – 1) + C1 (r2/4) + C2 log r + c3<br>D. W = (q r2/π D) (log r – 1) + C1 (r2/4) + C2 log r + c3 | |
| | 3 | Equation of deflection for simply supported circular plate subjected to center point load<br>A. W = q / 16 π D {2 r2 log (r/a) - [(3+ μ)/ (1+ μ)]}<br>B. W = q / 16 π D {2 r2 log (r/a) - [(3+ μ)/ (1+ μ)]}<br>C. W = q / 16 π D {2 r2 log (r/a) + [(3+ μ)/ (1+ μ)] (a2 + r2)}<br>D. W = q / 16 π D {2 r2 log (r/a) + [(3+ μ)/ (1+ μ)] (a2 – r2)} | |
| | 4 | Equation of deflection for fixed circular plate subjected to center point load<br>A. W = q r2/16 π D {2 log (r/a) + 1}<br>B. W = q r2/16 π D {2 log (r/a) – 1}<br>C. W = q r2/16 π D {2 log (r/a) + 1 + (a2/ r2)}<br>D. W = q r2/16 π D {2 log (r/a) – 1 + (a2/ r2)} | |
| | 5 | Equation of deflection for circular plate with circular hole at the center when the moments M1 and M2 uniformally distrubated over inner and outer boundries<br>A. W = [2 r2/ 4D (1+μ)] {(b2 M1- a2 M2)/( a2 - b2)} + { [a2 b2 (M1-M2)/ (1-μ)D(a2 - b2)] log (r/a)} + [a2/2D(1+μ) [ (a2 M2- b2 M1)/( a2 - b2)]<br>B. W = [2 r2/ 4D (1+μ)] {(b2 M1- a2 M2)/( a2 - b2)} - { [a2 b2 (M1-M2)/ (1-μ)D(a2 - b2)] log (r/a)} + [a2/2D(1+μ) [ (a2 M2- b2 M1)/( a2 - b2)]<br>C. W = [2 r2/ 4D (1+μ)] {(b2 M1- a2 M2)/( a2 - b2)} + { [a2 b2 (M1-M2)/ (1-μ)D(a2 - b2)] log (r/a)} - [a2/2D(1+μ) [ (a2 M2- b2 M1)/( a2 - b2)]<br>D. W = [2 r2/ 4D (1+μ)] {(b2 M1- a2 M2)/( a2 - b2)} - { [a2 b2 (M1-M2)/ (1-μ)D(a2 - b2)] log (r/a)} - [a2/2D(1+μ) [ (a2 M2- b2 M1)/( a2 - b2)] | |
| | 6 | Bending moment equation of deflection for circular plate with circular hole at the center when the moments M1 and M2 uniformally distrubated over inner and outer boundries<br>A. Mr = [a2 b2 (M1-M2)/ r2 (a2 - b2)] + [(b2 M1 - a2 M2)/( a2 - b2)]<br>B. Mr = [a2 b2 (M1-M2)/ r2 (a2 - b2)] - [(b2 M1 - a2 M2)/( a2 - b2)]<br>C. Mr = [a2 b2 (M1-M2)/ r2 (a2 - b2)]<br>D. Mr = [a2 b2 (M1-M2)/ r2 (a2 + b2)] | |
| | 7 | Equation of deflection for circular plate with circular hole at the center when the moments M1 uniformally distrubated over inner boundries<br>A. W = [1/ 2D (1+μ) (b2 M1)/( a2 - b2)(r2 – a2)] + [a2 b2 M1/ (1-μ)D(a2 - b2)] log (r/a)<br>B. W = [1/ 2D (1+μ) (b2 M1)/( a2 - b2)(r2 – a2)] - [a2 b2 M1/ (1-μ)D(a2 - b2)] log (r/a)<br>C. W = 1/ 2D (1+μ) (b2 M1)/( a2 - b2)(r2 – a2)<br>D. W = 1/ 2D (1+μ) (b2 M1)/( a2 - b2)(r2 + a2) | |

**Name of the Prgogram:- M.Tech (Structural Engineering )**

**Semester: - I[st] Sem. ( 2021- 2022 )**

**Course Code :- 20PCI103D** **Name of the Course :- Advanced Structural Analysis**

**Max Marks: 60** **Time:- 3 Hours**

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**Instructions:**

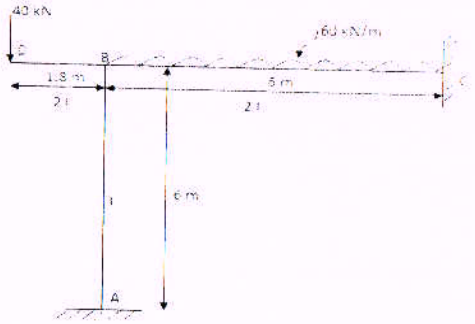
1. **Question No. 1 & 6 are compulsory.**
2. **Solve any two questions from remaining questions.**
3. **Assume suitable data if required.**

Q. 1. a) Distinguish between flexibility and stiffness matrix method **10 Marks**

Q.2. a) Explain the procedure of flexibility matrix method. **05 Marks**

b) Analyse the portal frame ABCD by flexibility matrix method. The support A is fixed and D is hinged. The details of the beam are as under:
The column AB is 6 m long and carrying a point load 100 KN at mid span.
The beam BC is 4 m span and carrying udl of 25 KN/m over entire on beam.
The column CD is 3 m long and carrying a udl of 10 KN/m over entire span.
Take EI is constant. **15 Marks**

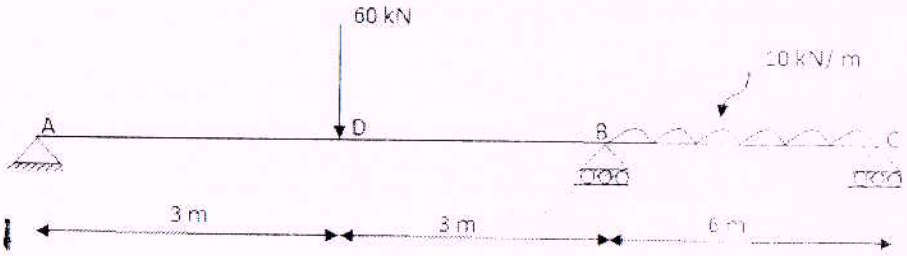
Q. 3. a) Analyse the given portal frame by generalized flexibility matrix method. **15 Marks**




b) Explain the procedure of Stiffness matrix method. **5 Marks**

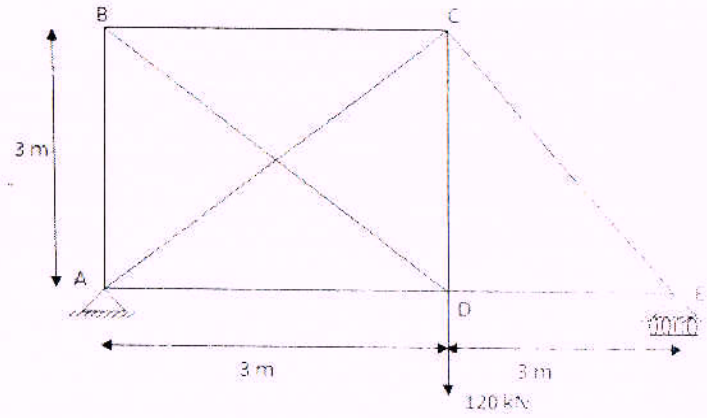
Q.4.a) Explain in detail lack of fit. **5 Marks**

b) Analyse the continuous beam ABC by Stiffness matrix method as shown in fig. Take EI is constant. **15 Marks**




Q.5.a) Assumptions of Approximate method analysis. **5 Marks**

b) Determine the forces in all the members of the given truss. Assume AE is constant. **15 Marks**




Q.6.a) Distinguish between Statically determinate & statically indeterminate Structures. **05 Marks**

b) Explain Geometric Non-Linearity **05 Marks**

**Name of the Prgogram:- M.Tech (Structural Engineering )**

**Semester: - II[st] Sem. ( 2021- 2022 )**

**Course Code :- 20PCI205E-B**

**Name of the Course :- (Elective IV ) Advanced Design of Reinforced Concrete Structures.**

**Max Marks: 60** **Time:-3Hours**

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**Instructions:**

1. **All questions carrying equal marks.**
2. **Solve any Three questions from the following.**
3. **Assume suitable data if required.**

Q. 1. a) State the assumptions in the design of Silos by Janssen's Theory **5 Marks**

b) Design a R.C.C. retaining wall to retain the leveled earth embankment 5m high above the ground level. The unit weight of the earth is 17 KN/m$^3$ and its angle of repose is 30 degree. The S.B.C. of soil is 150 KN/ m$^1$. The Coefficient of friction between Soil and concrete is 0.50. Use $M_{20}$ grade of concrete and $Fe_{415}$ grade of steel. **15 Marks**

Q.2. a) Differentiate between Bunkers and Silo's. **5 Marks**

b) Design the intermediate secondary beam by the following data :
The building is having six columns, Outer four columns are having 300 mm x 300 mm size and the intermediate two columns are having 400 mm x 400 mm size. All the columns are placed a space of 4.5 m C/C distance. Columns are having a load of 780 KN each. In addition to this each column carries a moment of 150 KN-m due to wind load on the length of the building. Use $M_{20}$ grade of concrete and $Fe_{415}$ grade of steel. **15 Marks**

Q. 3. a) What are the methods available for Yield line analysis of slabs. **5 Marks**

b) A cylindrical Silo has an internal diameter of 6.5 m and 22 m deep with a conical hopper bottom. The material is stored is wheat with a density of 8 KN/m$^3$. The coefficient of friction between wall and material is 0.4. The ratio of horizontal to vertical pressure is 0.45. The angle of repose is 25 degree. Design the reinforcements in the silo walls. Use $M_{20}$ grade of concrete and $Fe_{415}$ grade of steel. **15 Marks**

Q.4.a) Explain the various kinds of joints used in water tanks. **5 Marks**

b) Design a circular bunker to store 210 KN of coal. The density of coal is 9.5 8 KN/m$^3$, The angle of repose is 30 degrees. $M_{20}$ grade of concrete and $Fe_{415}$ grade of steel. **15 Marks**

Q.5.a) Explain in detail the types of water tank. **5 Marks**

b) Design an elevated circular water tank of 500 Kiloliter capacity with top dome. The tank is supported on masonary tower. The depth of the water tank is 5m.Take unit weight of water is 12 KN/m$^3$ Assume live load is 1.0 KN/ m$^2$
Use $M_{20}$ grade of concrete and $Fe_{415}$ grade of steel. **15Marks**

Q.6.a) What are the boundary conditions of Yield lines. **5 Marks**

b) Design a post tensioned pre-stress concrete two way slab 9m x 11m in size to support the live load of 5kN/m$^2$. If the cables of 6 wires of 4mm diameter is stressed to 1500 N/mm$^2$ are available for the use, find the number of cable in two directions. Check for safety against collapse.
Use $F_{ck}$ = 40 N/mm$^2$, $f_p$ = 1600 N/mm$^2$. **15 Marks**

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All the best

Name of the Prgogram :- M.Tech (Structural)

Semester: - I[st] SEM

Course Code :- 20PCI102D Name of the Course :- Structural Dynamics

Max Marks: 60 Time:- 3 Hours

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Instructions:

1. Answer all questions.
2. Each question carries 10 marks (6+4)

Q. 1.

a) With a neat schematic representation explain SPRING-MASS-Damper system for SDF. **6 Marks**

b) Define: a) Free Vibration b) Forced Vibration **4 Marks**

Q.2.

a) Derive an expression for response of un-damped system under harmonic force. **6 Marks**

b) Define: a) Unit Impulse b) Ramp Forces **4 Marks**

Q. 3.

a) Explain time stepping method and interpolation method for numerical evaluation of dynamic responses. **6 Marks**

b) Write any 2 shape-functions under free vibration for SDF system. **4 Marks**

Q.4.

a) Explain in detail the general approach for linear systems with discretization, elastic forces, damping forces and inertia forces. **6 Marks**

b) List any 4 differences between responses of symmetric and asymmetric systems subjected to ground motion. **4 Marks**

Q. 5.

a) With a neat diagram explain the response of multiple storey building under natural vibration frequencies. **6 Marks**

b) State the meaning of orthogonality and Normalization of modes in Dynamic analysis linear systems. **4 Marks**

Q.6.

a) Explain any three differences between analysis of Linear and Non Linear systems in Numerical Evaluation of Dynamic Response. **6 Marks**

b) Mention the steps involved in Rayleigh-Ritz method of evaluation of dynamic response. **4 Marks**

**Second Term Exam A. Y. 2021 – 2022 (Jun – Jul 22)**

**Programme name: M. Tech. (Structural Engineering) 2nd Semester Exam**

Course Code: 20PCI202D | Name of the course: FEA for Structural Engineers

Max Marks: 60 | Duration: 3 hrs

**Instructions:**

(a) Write your answers clearly and legibly.
(b) Assume suitable data where required.
(c) Write precise and to-the-point answers.
(d) Use illustrations and flowcharts where required.
(e) Answer all the parts of the same question, together.

Q.1 Answer any two

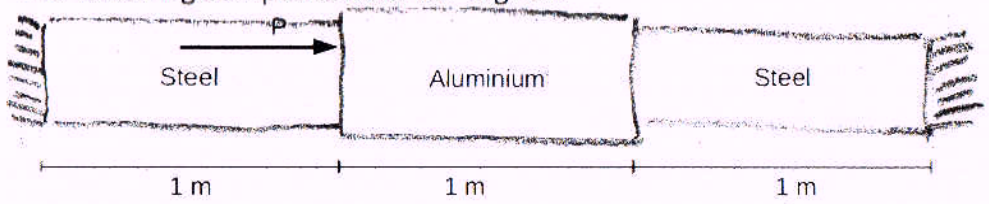
a. Write a short note on the mathematical modelling of Engineering problems. 5
b. What are the merits and demerits of finite element analysis? 5
c. Solve $y'' - x = 0, 0 \leq x \leq 1$, with the boundary conditions $y(x = 0) = 0$, and $y(x = 1) = 0$, with the Galerkin's method. 5

Q.2 Answer any two

a. Derive the linear interpolation function for prismatic element. 5
b. What are serendipity elements? Explain. 5
c. Write a short note on the Euler – Lagrange equations. 5

Q.3 Answer any two

a. The following composite axial bar is given 5




Given that $P = 10$ kN, $E_{st} = 200$ GPa, $A_{st} = 1 \times 10^{-2}$ sq. m., $E_{al} = 70$ GPa, $A_{al} = 2 \times 10^{-2}$ sq. m., analyse the composite axial bar in terms of internal and external forces.

b. Describe the space truss system in the context of FEA. 5
c. Describe the two-node isoparametric formulation. 5

Q.4 Answer any one

a. Describe the constant strain triangular element. 10
b. Describe the conditions for applications of plane stress and plane strain. 10

Q.5 Answer **any one**

a. Explain non-axisymmetric loading. 10
b. Explain the 8-node isoparametric element. 10
c. Explain the isoparametric formulation for 3D element. 10

Q.6 Answer **any one**

a. Explain the Finite Element formulation for non-linear analysis. 10
b. Write a short note on the solution of non-linear equations. 10

**M-Tech in Structural Engineering - First Year (I Semester) Examination**

**Design of Prestressed Concrete Structures**

**Paper Code:** MSEPEC105-B

**Feb / March - 2022**

**SET - I**

**Instructions to the Students:**

1. Illustrate your answers with neat sketches, diagram etc wherever necessary
2. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly.
3. Use of IS 1343:1980 is allowed

| Q. No. | | Question | Marks |
|---|---|---|---|
| Q1 | | A beam carries UDL of 4 KN/m exclusive of self weight. It is prestressed with 120 wires of 5mm diameter with their centroid 100mm above the bottom and the initial stress is 1000N/mm2. Assuming 15% losses, find the extreme fibre stresses at the various stages at mid span.Top Flange- 750mm x 200mm, Bottom Flange- 400m x 300mm, Web- 150mm x 500mm, Span of the beam- 30m. Stage-I- (Transfer stage)- Initial prestress force+ Self weight Stage-II- (Working stage)- Final prestress force+ Self weight + Live load | 10 |
| | | | |
| Q2 | A | Solve the following questions | |
| | 1 | Explain the design procedure of Prestressed composite section | 6 |
| | 2 | Explain the types of composite construction with neat sketch. | 6 |
| | B | Solve the following questions | |
| | 1 | A precast pretensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam with an effective span of 5m is prestressed by the tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150kN. The loss of prestress is 15%. The top flange width is 400mm with the thickness of 40mm.If the composite beam supports a live load of 8kN/m2 calculate the resultant stresses developed if the section is propped and unpropped. | 8 |
| | | **OR** | |
| Q3 | A | Solve the following questions | |
| | 1 | What are advantages and disadvantages of continuous Prestressed concrete members | 6 |
| | 2 | Explain the etrms a) Primary moment b) Secondary moment c) Resultant moment d) Redundant reaction with respect to continuous prestressed concrete beams. | 6 |
| | B | Solve the following questions | |
| | 1 | A continuous prestressed concrete beam ABC , AB=BC=10m has a rectangular cross section width 100mm and depth 300mm. The cable carring effective prestress force of 360KN is parallel to the axis of beam and located at 100mm from soffit. Find 1) The secondary and resultant moment at the central support 2) If the beam support impose load of 1.5 KN/m. Calculate the resultant stress at top and bottom of beam. Assume density of concrete 24 KN/m3. | 8 |
| | | | |
| Q4 | | Solve the following questions | |
| | 1 | What are the different ways of improving the shear resistance of structural concrete members by prestressing techniques? | 6 |
| | 2 | Distinguish between web shear, flexural and flexural shear cracks in concrete beams with neat sketches. | 6 |
| | B | Solve the following questions | |
| | 1 | A pre-tensioned prestressed s/c has a flange 1200 mm width and 150 mm thick. The width and depth of rib is 300 mm & 1500 mm respectively. High tensile steel has a area of 4700 $mm^2$ & is located at effective depth of 1600mm. If the characteristic cube strength of concrete & tensile strength of steel are 40 $N/mm^2$ & 1600 $N/mm^2$. Calculate the Flexural strength of S/C. | 8 |

# DEPARTMENT OF CIVIL ENGINEERING
# JAWAHARLAL NEHRU ENGINEERING COLLEGE, MGM UNIVERSITY

Programme: M. Tech. Structural Engineering ✓ Academic Session: 2021 - 2022 - I
Course: Advanced Nunerical Methods for Structural Engineers Max Marks: 60
Examination: End-semester 20PCSI04A Time: 3 hrs

1. (a) Roots of an equation can be found by A. Newton - Raphson Method B. Bisection Method C. Regular Falsi Method D. All of these (1)

   (b) A set of simultaneous equations can be solved by A. Gauss - Legendre Method B. Gauss - Laguerre Method C. Gauss - Siedel Method D. None of these (1)

   (c) An efficient and fast computing interpolation method is A. Newton - Raphson method B. Newton - Leibniz method C. Newton's interpolating polynomial D. Lagrange's interpolating polynomial (1)

   (d) The bracketing based root finding methods require that A. The initial solutions lead to functional values with opposite signs. B. The initial solutions lead to functional values with same signs. C. The initial solutions lead to functional values with no signs. D. All of these (1)

   (e) The inital value problem is a A. Second order differential equation with two known values at the beginning of the interval. B. First order differential equation with one known value at the beginning of the interval. C. Third order differential equation with two known values at the beginning of the interval and one known value at the end of the interval. D. None of these (1)

   (f) The quadrature method is A. Classical method of differentiation. B. Numerical method of differentiation C. Classical method of integration D. Numerical method of integration (1)

   (g) Numerical analysis can be performed with A. MATLAB B. Scilab C. MAPLE D. All of these (1)

   (h) The Runge Kutta method can be used to solve A. Boundary value problems B. Boundary element method C. Finite value problems D. Initial value problems (1)

   (i) The trapezoidal rule is a A. classical integration method B. classical differentiation method C. numerical integration method D. numerical differentiation method (1)

   (j) The regression method is for A. model fitting B. model making C. curve making D. curve fitting (1)

2. A civil engineer involved in construction requires 4800 cu.m. of sand, 5800 cu.m. of fine gravel, and 5700 cu.m. of coarse gravel for a building project. There are three pits from which these can be obtained, where the compositions are given as follows: (10)

| | Sand % | Fine Gravel % | Coarse Gravel % |
|---|---|---|---|
| Pit 1 | 52 | 30 | 18 |
| Pit 2 | 20 | 50 | 30 |
| Pit 3 | 25 | 20 | 55 |

   How many cubic meters must be hauled from each pit in order to meet the engineer's needs.

3. (a) Explain the bisection method. (3)

   (b) A uniform beam is subject to a linearly increasing distributed load. The equation for the resulting elastic curve is (7)

$$y = \frac{w_0}{120EIL}\left(-x^5 + 2L^2x^3 - L^4x\right)$$

Use the bisection method to determine the point of maximum deflection (i.e. the value of $x$ where $\frac{dy}{dx} = 0$.). Substitute this value into the above equation to find the maximum deflection. Use $L$ = 600 cm, $E$ = 50,000 kN/cm$^2$, $I$ = 30,000 cm$^4$, and $w_0$ = 2.5 kN/cm.

4. (a) Write a short note on the Lagrange interpolation with special focus on the Lagrange's basis functions and the Lagrange's interpolating polynomial. (3)

   (b) Let $X = \{0, 0.3, 0.6, 0.9, 1\}$. Consider the function (7)

$$f(x) = \frac{1}{1+x^2}.$$

   Construct the set $Y = \{y \mid y = f(x), \forall\, x \in X\}$. Using this data, find the value of the Lagrange's Interpolant at $x = 0.5$, and compare it the value of the function at the same point. Calculate the percentage error.

5. (a) Explain the concept of quadrature. (1)

   (b) Write a short note on the Simpson's 1/3 rule (4)

   (c) Solve the following problem with the Simpson's 1/3 rule, with a step size of $h = 0.1$: (5)

$$\int_0^1 \left(e^{-x+8}x^2\right) dx$$

6. (a) Explain the concept of the initial value problem. (1)

   (b) Explain the Runge Kutta method. (4)

   (c) Using the Runge Kutta method, solve the following initial value problem, and determine the value of $y$ at x = 1, with a step size of h = 0.25: (5)

$$\frac{dy}{dx} = e^{-2(x+y)} \text{ with } y(x=0) = 5$$