

Index

A

ADINA

- beam structure subjected to an end moment, 251, 253
- case study, stress analysis of a dental bridge, 256–262
- central difference algorithm, 65–67
- discussion example, 189–192
- Global FE matrices and vectors for 3-D, 150–151
- laminated composite cylindrical roof loaded under its own weight, 307–309
- meshing, 266–269
- modal analysis of a micro transducer, 126–128
- program, 67, 111, 130, 142–144, 151–152, 207, 228, 230, 251, 308
- Scordelis-Lo cylindrical roof, 227–230
- 3D structure, 151–153
- truss structure subjected to a vertical load, 104–112
- 2D structure subjected to a vertical load, 142–146

Admissible function, 44

Area coordinates, 160

Axisymmetric

- elements, 275, 276
- geometry, 275
- problems, 275
- solids, 275

B

- Beam, 21, 22, 25, 28–31, 33, 38–41, 60, 62, 115–154, 189–192, 199, 215, 229, 233,

241, 251–255, 262, 265, 274, 276, 277, 279–282, 307

- Beam element(s), 115–117, 119, 120, 122, 128, 130, 131, 136–138, 140–143, 146–148, 151, 154, 188, 189, 199, 215

Bending

- conditions, 8, 11–21
- moments, 30–31, 34, 38–40, 123, 146, 191, 252, 253, 306
- stiffness, 18, 21, 33, 35, 36, 213, 215, 217, 305
- strains, 208, 210, 305

- Boundary conditions, 36, 37, 41, 44, 48, 51, 59–60, 90–93, 102, 103, 108, 111, 123, 125, 129, 130, 143, 151, 152, 190, 226–230, 233, 252, 253, 259, 273–275, 282, 307

C

Cauchy equations, 5–6, 284

Central difference algorithm, 65–67

Compatibility equations, 44

Composite(s)

- material(s), 37, 265, 307
- plate, 307
- shell, 308

Computational

- cost, 47
- effort, 185, 192, 214, 275

Conforming element(s), 200, 209

Consistency, 52–54, 83, 127, 166, 199

Constant strain, 40, 164, 188, 189, 230, 239

Constant stress, 164, 239

- Constitutive equations, 3–5, 10–11, 215, 283, 302
- Constraints, 14, 44, 45, 60, 71, 186, 229, 265, 272, 276–283, 295
- Continuity, 43, 44, 46, 117, 172, 188, 196, 198–200, 202, 206, 207, 269, 272, 278–280
- Convergence, 94, 130, 133, 186–189, 215, 257
- Coordinate mapping, 180
- Coordinate transformation, 58–59, 87, 89, 93, 95, 102, 103, 124, 139, 140, 150, 174, 181, 286
- Cubic element(s), 179, 230, 248–250
- D**
- Damping, 63, 64, 66, 70–77
- Delta function property, 55, 177, 249, 250
- Direct integration method, 64–71
- Discretization, 46–47, 92, 102, 103, 105, 124, 128, 133, 142, 179, 191, 215, 234
- Displacement field, 2, 7, 12–14, 18, 22, 23, 26, 29, 30, 34, 37, 38, 45, 46, 53, 55, 94, 103, 159, 162, 163, 166, 169, 188, 201, 230, 236, 242, 269, 271, 275, 283
- Dynamic equilibrium equation, 6–7, 11, 17–18, 24, 27, 28, 31, 33
- E**
- Eigenvalue analysis, 60–63, 133
- Element distortion, 268–270
- Element force vector, 58
- Element mass matrix, 113, 138, 150, 165, 184, 212
- Element matrices
- beam element, 128
 - plate element, 195, 215, 217, 219, 220, 230
 - shell element, 215–230
 - 3D solid element, 239, 240
 - truss element, 83, 84, 86–88, 90, 97, 98, 104, 150, 214
 - 2D solid element, 157–159, 165, 188, 195, 209, 215, 220
- Element stiffness matrix, 93, 102, 107, 113, 124, 166, 189, 239, 268, 304
- Euler-Bernoulli beam theory, 37
- F**
- Field, 1, 2, 7, 12–15, 18, 20, 22, 23, 25, 26, 29–31, 34, 35, 37, 38, 43–46, 53–56, 94, 103, 159, 162, 163, 166, 168, 177, 180, 187, 196, 201, 209, 230, 236, 242, 253, 269, 271, 275, 283, 295
- Finite element
- equation(s), 46, 56–59, 102, 109, 111, 131, 144, 152, 157, 165, 195, 283
 - procedure, 180
- Functional, 44, 215, 257
- G**
- Gauss elimination, 60
- Gauss integration, 172, 179, 184, 211, 212, 214, 245, 246
- Gauss points, 99–101, 185, 186, 214, 262
- Geometry modelling, 265–266
- Global coordinate system, 48, 58, 59, 86–90, 105, 106, 113, 122, 136, 139–141, 148, 150, 151, 155, 218–220, 225, 229, 300, 303
- H**
- h -adaptivity, 95
- Hamilton's principle, 43–46, 56
- Hexahedron element, 241, 242, 245, 254, 259, 262
- Higher order elements, 158, 166, 168, 186, 212, 247–251, 268
- I**
- Implicit method, 67, 71
- Initial conditions, 66, 73, 74, 77
- Interpolation functions(s), 49, 209
- Isoparametric element, 166, 185, 214, 221
- Isotropic, 4, 10, 15, 21, 23, 26–28, 30, 34, 35, 38, 91, 101, 113, 115, 154, 213, 227, 250, 259, 295, 307
- J**
- Jacobian matrix, 244, 246
- K**
- Kinetic energy, 44, 45, 56, 197, 209
- L**
- Lagrange basis, 89
- Lagrange elements, 248–249
- Lagrange polynomials, 95, 168
- Laminate(s)
- analysis, 301
 - coordinate system, 301, 302
 - plate, 304, 306–307

Linear acceleration method, 67
 Linear element(s), 95, 158, 174, 270, 271
 Linear field reproduction, 176
 Linear independence, 54
 Linear rectangular elements, 173–175, 183
 Linear triangular elements, 159–165, 168

M

Mass matrix, 56, 62, 66, 72, 86, 97, 98, 113, 121, 138, 150, 164, 165, 184, 193, 205, 218, 219, 239, 245, 246
 Material, 1, 4, 10, 12, 14–16, 21–23, 26, 28–30, 34, 35, 37, 38, 45, 63, 101, 105, 113, 115, 117, 127, 132, 133, 142, 151, 153, 158, 164, 184, 204, 227, 233, 239, 251, 259, 273, 283–309
 Mechanics, 1–41, 43, 44, 63, 92, 102, 145, 265, 267
 Membrane effect(s), 216, 219, 220
 Mesh compatibility, 265, 269–272, 278
 Mesh incompatibility, 270–272
 Mindlin plate, 207
 Modal analysis, 72–77, 126, 131
 Modelling, 142–144, 151–152, 215, 253, 254, 257, 265–309
 Modes of vibration, 73, 78, 133
 Moments, 3, 16, 17, 21, 26–28, 30–32, 34, 35, 38, 39, 60, 81, 104, 115, 121–125, 133, 142, 146–150, 153, 190–192, 229, 251–254, 277, 283, 305, 306
 Multi-point constraints (MPC), 272

N

Newmark algorithm, 70–71
 Non-conforming, 196, 200, 202

O

Offsets, 265, 276, 277
 Order of elements, 183, 270–272

P

p-adaptivity, 95
 Pascal pyramid, 50, 51
 Pascal triangle, 50, 173
 Planar beam(s), 116, 135–146
 Planar truss, 89, 90
 Plane strain, 9, 10, 157, 158, 164, 184, 189

Plane stress, 8–11, 15–17, 20, 157, 158, 164, 184, 188, 189, 191, 195, 204, 213, 215, 217, 275, 301

Plate element(s), 17, 195, 197, 206, 208, 209, 213, 215, 217, 219, 220, 230

Poisson's effect, 235

Polynomial

basis functions, 162, 202, 236
 interpolation, 169

Potential energy, 44, 45, 197

Q

Quadratic element(s), 158, 176, 247, 249, 270, 271

Quadrilateral element(s), 159, 166, 171, 179–186

R

Rate of convergence, 94

Rectangular element(s), 171–179, 183, 196, 198–201, 206, 248, 249, 268

Reissner-Mindlin, 12, 18–21, 196, 207, 209, 213, 226, 227, 254, 279, 306

S

Serendipity type elements, 249–251

Shape functions

properties, 54, 82, 116
 standard procedure for constructing, 49
 sufficient requirements, 199

Single point constraint, 272

Singularity point, 214

Space truss(es), 90

Static analysis, 60, 190, 259

Strain displacement relation/relationship(s), 2, 197

Strain energy, 21, 41, 56, 188, 208, 210, 214, 218, 285, 295, 296, 307

Strain matrix, 57, 85, 97, 120, 158, 181, 183, 184, 204, 225, 239, 243, 245

Strong form, 43, 44, 91, 101, 122, 251

Superparametric elements, 166, 167, 169, 170

Supports, 59, 81, 83, 104, 115, 118, 142, 143, 151, 190, 192, 226, 227, 256–258, 261, 265, 273

Symmetry

axial, 272, 275–276
 plane, 273–275

T

Tetrahedron element, 234–239, 247–248, 259, 262, 268
Thick plate theory, 12
Thin plate theory, 195, 196, 207
Timoshenko beam theory, 28, 191
Torsional, 26, 27, 35, 149
Transformation matrix, 59, 72, 87–89, 93, 122, 141, 150, 220, 286, 287, 289, 297–299, 302
Transient
 analysis, 63–78, 132–135, 155
 dynamic analysis, 77
 response, 75
Triangular element(s), 159–166, 168–171, 179, 181, 206

Truss(es), 1, 22–24, 28, 81–112, 115, 137, 139, 142, 146, 148–150, 153, 158, 189, 214, 215, 233, 265

V

Variational principle(s), 44
Vibration
 modes, 61, 62, 78, 133–134
 problems, 78
Volume coordinates, 236, 237, 248

W

Weak form, 43–44
Wilson θ algorithm, 67–70