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# LIST OF SYMBOLS AND ABBREVIATIONS

## Symbols

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<th>Symbol</th>
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<tr>
<td>$(\sigma_m)_{\text{all}}$</td>
<td>allowable axial stresses for the $m^{th}$ member</td>
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<td>$\sigma_i^b$</td>
<td>allowable buckling stress in member $i$ when it is in compression</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Bending stress</td>
</tr>
<tr>
<td>$f^*(x)$</td>
<td>best known optimum objective function value</td>
</tr>
<tr>
<td>$x^*$</td>
<td>best known optimum solution to the function</td>
</tr>
<tr>
<td>$b$</td>
<td>breath of welded beam</td>
</tr>
<tr>
<td>$P_c$</td>
<td>Buckling load</td>
</tr>
<tr>
<td>$c_{ij}$</td>
<td>closeness index of work flow between facilities $i$ and $j$</td>
</tr>
<tr>
<td>$\sigma_m$</td>
<td>computed axial stresses for the $m^{th}$ member</td>
</tr>
<tr>
<td>$e_i$</td>
<td>constants from the valve-point loading effect of generators</td>
</tr>
<tr>
<td>$f_i$</td>
<td>constants from the valve-point loading effect of generators</td>
</tr>
<tr>
<td>$\delta_{j,k}$</td>
<td>constraint being bound on displacements</td>
</tr>
<tr>
<td>$s_m$</td>
<td>constraint being bound on slenderness ratio</td>
</tr>
<tr>
<td>$g_m$</td>
<td>constraint being bound on stresses</td>
</tr>
<tr>
<td>$D_i$</td>
<td>continuous set or as a discrete set</td>
</tr>
<tr>
<td>$a_i$</td>
<td>cost coefficients of generation unit $i$</td>
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<tr>
<td>$b_i$</td>
<td>cost coefficients of generation unit $i$</td>
</tr>
<tr>
<td>$c_i$</td>
<td>cost coefficients of generation unit $i$</td>
</tr>
<tr>
<td>$C_{MK}$</td>
<td>cost per unit distance for resources Mk flow</td>
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</table>
C_e - critical slenderness ratio parameter
A_i - cross-sectional area of member i chosen between A_min and A_max
$t$ - depth of welded beam
g_j({x}) - design constraints
d_{j,k} - displacements computed in the k^{th} direction of joint j
d_{ij} - distance between location i and j
d_{kl} - distance between the facilities k and l
M_{Lmki,j} - distance travelled by resource Mk flow per unit time between locations i and location j
K_m - effective length factor of m^{th} member
$\delta$ - End Deflection
$B$ - Euclidian distance between Dog ‘i’ and ‘j’
x_{ik} - facility I is assigned to location k
x_{jl} - facility j is assigned to location l
$!$ - Factorial
$F_j$ - fitness of dog j
$FL_{Mki,j}$ - frequency of resource Mk flow between location I and j per unit time
$f_{ij}$ - frequency trips made by construction personnel between facilities i and j
$F_i(P_i)$ - fuel cost function of unit I
$Gilbest$ - Global best
in - Inch
R - inner radius of the pressure vessel
ksi - Kilogram per square inch
$L_i$ - length of member i
L - length of the cylindrical segment of the pressure vessel
L_m - length of the member m
l - length of weld used in welded beam
L_{best} - Local best
\gamma_i - material density of member i
x_{i,max} - maximum allowable values for the design variable x_i
\sigma_{max} - Maximum bending stress
\hat{\sigma}_{max} - Maximum end deflection
P_{i,max} - Maximum generation limits of unit i
\tau_{max} - Maximum shear stress
D - mean coil diameter of the Tension/Compression Spring
A - mean Euclidian distance of all dogs
MW - Mega Watt
x_{i,min} - minimum allowable values for the design variable x_i
P_{i,min} - Minimum generation limits of unit i
R_m - minimum radii of gyration
G - Modulus of rigidity
x_{i,new} - New position of design variable
g_n - n_{th} Constraints
N_c - number of active coils of the Tension/Compression Spring
P - number of available variables
n_c - number of compression elements
N - number of constraints
N_d - Number of design variables
n - number of facilities, or locations
N_g - number of groups (number of design variables)
M - number of inequality functions
N_m - Number of members
m - number of nodes
K - number of problem specified behavioral constraints

Nu - number of units in the system

f(x) - objective function

P_best - Particle best

\{X_1, X_2, \ldots, X_p\} - permissive discrete variables

P - Permutation

\delta_{x_i} - permutation matrix variable

lb - Pounds

Psi - Pounds per square inch

P_i - Power output of unit i

g_j(x) - problem specified behavioral constraints

S_d - Scalar function

x^1, x^2, \ldots, x^d - set of design variables

X - set of each design variable (x_i)

X_i - set of the possible range of values for each design variable

\tau - Shear stress

h - size of weld used in welded beam

\lambda_m - slenderness ratio

C - step reduction coefficient

\Sigma F - sum of fitness of all dogs having fitness value higher than fitness of dog i

T_s - thickness of the cylindrical skin of the pressure vessel

T_h - thickness of the spherical head of the pressure vessel
TCL_{Mk,i,j} - total cost of resource Mk flow between locations i and j
F_t - Total fuel cost
P_D - Total load demand
N_j - total number of joints
P_{Loss} - Transmission loss
f(x_1, x_2, \ldots, x_d) - truss’s weight function
F_u - ultimate tensile strengths
\rho_m - unit weight of the member m
I - vector integer values
Rand - vector of size N having random values varying from 0 to 1
W(\{x\}) - weight of the structure
W - weight of the truss structure
d - wire diameter of the Tension/Compression Spring
XL_i - X coordinate of the locations within the site area
YL_i - Y coordinate of the locations within the site area
F_y - yield tensile strengths
E - Youngs Modulus
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ABC</td>
<td>Artificial Bee Colony</td>
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<tr>
<td>ACO</td>
<td>Ant Colony Optimization</td>
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<tr>
<td>AGA</td>
<td>Augmented genetic algorithm</td>
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<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
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<tr>
<td>APPROX</td>
<td>Griffith and Stewart’s successive linear approximation</td>
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<tr>
<td>ASD – AISC</td>
<td>Allowable Stress Design Code of American Institute of Steel Construction</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>AWD</td>
<td>African Wild Dog</td>
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<td>AWDA</td>
<td>African Wild Dog Algorithm</td>
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<tr>
<td>BB-BC</td>
<td>Big Bang–Big Crunch</td>
</tr>
<tr>
<td>CP</td>
<td>Charged particle</td>
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<td>CS</td>
<td>Cuckoo Search</td>
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<tr>
<td>CSLP</td>
<td>Construction Site Layout Planning</td>
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<tr>
<td>CSS</td>
<td>Charged System Search</td>
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<td>DAVID</td>
<td>Davidon–Fletcher–Powell with a penalty function</td>
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<td>EA</td>
<td>Evolutionary Algorithm</td>
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<tr>
<td>ED</td>
<td>Economic Dispatch</td>
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<tr>
<td>EDP</td>
<td>Economic Dispatch Problem</td>
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<tr>
<td>EP</td>
<td>Evolutionary Programming</td>
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<tr>
<td>EP-SQP</td>
<td>Hybrid Evolutionary Programming – Sequential Quadratic Programming</td>
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<tr>
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<td>Fire Fly Algorithm</td>
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<td>FLP</td>
<td>Facility Layout Problem</td>
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<td>GA</td>
<td>Genetic Algorithm</td>
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GP - Genetic Programming
GWS - Glow Worm Swarm
HPSO - Heuristic Particle Swarm Optimization
HS - Harmony Search
HSS - Hybrid Stochastic Search
MMAS-GA - Max-Min Ant System – Genetic Algorithm
NLP - Nonlinear Programming
PS - Powell and Skolnick’s constraint handling method
PSO - Particle Swarm Optimization
PSO-IIW - Particle Swarm Optimization With Improved Inertia Weight
PSOPC - Particle Swarm Optimization with Passive Congregation
PSO-SQP - Particle Swarm Optimization – Sequential Quadratic Programming
RANDOM - Richardson’s random method
SA - Simulated Annealing
SI - Swarm Intelligence
SIMPLEX - Simplex method with a penalty function
TD - Total Distance
TS - Tabu Search
TS-R - Tournament Selection