UDC 519.6 EDN: RGSEIK

REAL POWER LOSS REDUCTION BY BASKETBALL LEAGUE ALGORITHM

L. Kanagasabai gklenin@gmail.com

Prasad V. Potluri Siddhartha Institute of Technology, Kanuru, Vijayawada, India

Abstract

In this paper Basketball League (BL) algorithm is applied to solve the power loss lessening problem. BL algorithm has been modelled based on the actions of BL squad. Basketball League game characteristically entails of 4 quarters and each one is ten minutes. Subsequently double quarters the squads shift sides on the courtyard. The squad with extra points at the conclusion of the 4 quarters triumphs the competition. If the total is tied at the conclusion of ruling time, the play will be preceded to additional time period. A bellicose competitor can possess the ball stirring round the court by drooling or fleeting the basketball to a co-player. In a ball drool, a competitor requests to rebound the basketball counter to the base incessantly practice single hand in a period. Using the both hands concurrently drool the basketball two times previously it rebounds on one occasion establishes a twofold drool defilement, which finishes in relinquishing control to the rival squad. Basketball team possess 12 players, with 5 players on the courtyard with Limitless replacements are permissible. Players in BL are alienated into consistently fragmented squads grounded upon age, capability, and proficiency. Elucidation has been generated grounded on the squad, players, trainer, and replacement approach. Principally fitness utility for every solution will be calculated and the consequence of competition amongst any two squads playing in BL is anonymous; some squad can triumph at the conclusion. Obviously when squad "*i*" win over squad "*j*" it's owed to the influence of the winning squad correspondingly it will be pathetic point for the dropping squad. Initial solution of the problem is engendered and squads are initialized contingent on the creation of the squad with strategies. Initial

Keywords

Optimization, power, transmission loss, Basketball league algorithm

solution of the problem is engendered and squads are initialized contingent on the creation of the squad with strategies. Trainers are playing principal part in providing effective contribution to the squad. Correspondingly trainers modify the strategies throughout the competition in the direction of competition wining. Rendering to the performance in the specific period elevation and relegation of the squads will be present. Supremely accomplished squads will be endorsed to eldest competition and deprived performed squad will be downgraded to junior division league. Legitimacy of BL algorithm is corroborated in IEEE 30 bus system and IEEE 14, 30, 57, 118, 300 bus test systems without considering the power constancy index. True power loss lessening, voltage divergence curtailing, and voltage constancy index augmentation has been attained

Received 19.10.2021
Accepted 30.12.2021

Introduction. Optimal reactive power dispatch is envisaged as one of the remarkable circumstances for safe and fiscal operation of system. It is consummate by appropriate organization of the edifice apparatus used to cope up the power flow with the goal of diminishing the true power losses and progress the voltage outline of the structure. Zhu *et al* [1] solved the optimal reactive power control using modified interior point method. Quintana *et al* [2] did reactive-power dispatch by successive quadratic programming. Jan *et al* [3] did application of the fast Newton — Raphson economic dispatch and reactive power/voltage dispatch by sensitivity factors to optimal power flow. Terra *et al.* [4] did security-constrained reactive power dispatch. Grudinin [5] did Reactive power optimization using successive quadratic programming method. Ebeed *et al* [6] did the optimal reactive power dispatch using marine predators algorithm considering the uncertainties in load and wind-solar generation systems. Sahli *et al* [7] did reactive power dispatch optimization with voltage profile improvement using an efficient hybrid algorithm. Davoodi *et al* [8] did a novel fast semidefinite programming-based approach for optimal reactive power dispatch. Bingane *et al* [9] applied tight-and-cheap conic relaxation for the optimal reactive power dispatch problem. Sahli *et al* [10] applied hybridized PSO-Tabu exploration for the problem. Mouassa *et al* [11] applied Ant lion algorithm for solving the problem. Mandal *et al* [12] solved the problem by using quasi-oppositional teaching. Khazali *et al* [13] solved the problem by harmony search procedure. Tran *et al* [14] solved problem by innovative enhanced stochastic fractal search procedure. Polprasert *et al* [15] solved the problem by using enhanced pseudo-gradient pursuit particle swarm optimization. Thanh *et al* [16] solved the problem by an operative metaheuristic procedure. Adolph *et al* [17] had done research on the golden age of amateur basketball: the AAU Tournament. Brown *et al* [18] did a study on a basketball. Forrest *et al* [19] did a research on basketball. Illinois Center [20] for a Smarter Electric Grid (ICSEG) IEEE 30 bus system data obtained. Dai *et al* [21] used seeker optimization procedure for solving the problem. Subbaraj *et al* [22] used self-adaptive real coded genetic procedure to solve the problem. Pandya *et al* [23] applied Particle swarm optimization to solve the problem. Nasser Hussain *et al* [24] applied amended particle swarm optimization to solve the problem. Vishnu *et al* [25] applied an enhanced particle swarm optimization to solve the problem. Omelchenko I.N. *et al* [26] did development of a design algorithm for the logistics system of product distribution of the mechanical engineering enterprise. Omelchenko I.N. *et al* [27] did the work on organization of logistic systems of scientific productions. Omelchenko I.N. *et al* [28] solved the problems and organizational and technical solutions of processing management problems of material and technical resources in a design-oriented organization. Khunkitti *et al* [29] solved multi-objective optimal power flow problems based on slime mould algorithm. Diab *et al* [30] solved multi-objective optimal power flow control of electrical transmission networks using intelligent meta-heuristic optimization techniques. In this paper Basketball League (BL) algorithm is applied to solve the real power loss lessening problem. In this paper BL algorithm has been modelled based on the actions of BL squad. The beginning of basketball is in 1891. Basketball is a squad game between two teams. The fundamental aim of the game is to notch points by positioning the ball inside the loop and to prevent the opposite squad to score the points. Basketball play starts at the middle of the courtyard once the ball is flung tall up by the umpire and single player from every team contending to increase control. The League team that clasps the ball is called the attacking squad whereas the side not on the ball is the apologetic squad. Basketball League game characteristically entails of 4 quarters and quarter duration is ten minutes. Subsequently double quarters the squads shift sides on the courtyard. The squad with extra points at the conclusion of the 4 quarters triumphs the competition. If the total is tied at the conclusion of ruling time, the play will be preceded to additional time period. A bellicose competitor can possess the ball stirring round the court by drooling or fleeting the basketball to a co-player. In a ball drool, a competitor requests to rebound the basketball counter to the base incessantly practice single hand in a period. Using the both hands concurrently drool the basketball two times previously it rebounds on one occasion establishes a twofold drool defilement, which finishes in relinquishing control to the rival squad. Basketball team possess 12 players, with 5 players on the courtyard with limitless replacements are permissible. Players in BL are alienated into consistently fragmented squads grounded upon age, capability, and proficiency. Elucidation has been generated grounded on the squad, players, trainer, and replacement approach. Principally fitness utility for every solution will be calculated and the consequence of competition amongst any two squads playing in BL is anonymous; some squad can triumph at the conclusion. Obviously when squad "*i*" win over squad "*j*" it's owed to the influence of the winning squad correspondingly it will be pathetic point for the dropping squad. Initial solution of the problem is engendered and squads are initialized contingent on the creation of the squad with strategies. Trainers are playing principal part in providing effective contribution to the squad. Correspondingly trainers modify the strategies throughout the competition in the direction of competition wining. Rendering to the performance in the specific period elevation and relegation of the squads will be present. Supremely accomplished squads will be endorsed to eldest competition and deprived performed squad will be downgraded to junior division league. Legitimacy of the BL algorithm is corroborated in IEEE 30 bus system and IEEE 14, 30, 57, 118, 300 bus test systems without considering the voltage constancy index. True power loss lessening, voltage divergence curtailing, and voltage constancy index augmentation has been attained.

Problem formulation. Power loss minimization is defined by $\min \tilde{F}\left(\overline{d}, \overline{e}\right)$, where min is minimization of power loss. Subject to the constraints $A\left(\overline{d}, \overline{e}\right) = 0$; $B\left(\overline{d}, \overline{e}\right) = 0$, *d*, *e* are control and dependent variables,

$$d = \left[VLG_1, \ldots, VLG_{Ng};\ QC_1, \ldots, QC_{Nc};\ T_1, \ldots, T_{NT}\right];$$
$$e = \left[PG_{slack};\ VL_1, \ldots,\ VL_{NLoad};\ QG_1, \ldots, QG_{Ng};\ SL_1, \ldots, SL_{NT}\right].$$

Here QC is reactive power compensators; T is tap setting of transformers; PG_{slack} is slack generator; VL_g is level of the voltage; QG is generation unit's reactive power; SL is apparent power.

The fitness function $\left(F_1, F_2, F_3\right)$ is designed for power loss (MW) lessening, voltage deviancy, voltage constancy index (L-index) is defined by:

$$F_1 = P_{\min} = \min\left[\sum_{m}^{NTL} G_m\left[V_i^2 + V_j^2 - 2V_iV_j \cos Ø_{ij}\right]\right];$$

$$F_2 = \min\left[\sum_{i=1}^{N_{LB}}\left|VL_k - VL_k^{desired}\right|^2 + \sum_{i=1}^{Ng}\left|QG_K - QK_G^{\lim}\right|^2\right];$$

$$F_3 = \min L_{\max},$$

where NTL is number of transmission line; VL_k is load voltage in k-th load bus; $VL_k^{desired}$ is voltage desired at the k-th load bus; QG_K is reactive power generated at k-th load bus generators; $QK_G^{\lim}$ is reactive power limitation; N_{LB}, Ng are number load and generating units; $L_{\max} = \max\left[L_j\right]$, $j = 1, \ldots, N_{LB}$,

$$L_j = 1 - \sum_{i=1}^{NPV} F_{ji} \frac{V_i}{V_j}, \quad F_{ji} = -\left[Y_1\right]^1 \left[Y_2\right]; \quad L_{\max} = \max\left[1 - \left[Y_1\right]^{-1} \left[Y_2\right] \frac{V_i}{V_j}\right].$$

Parity constraints:

$$0 = PG_i - PD_i - V_i \sum_{j \in NB} V_j \left[G_{ij} \cos\left[\varnothing_i - \varnothing_j\right] + B_{ij} \sin\left[\varnothing_i - \varnothing_j\right]\right];$$

$$0 = QG_i - QD_i - V_i \sum_{j \in NB} V_j \left[G_{ij} \sin\left[\varnothing_i - \varnothing_j\right] + B_{ij} \cos\left[\varnothing_i - \varnothing_j\right]\right].$$

Disparity constraints:

$$PG_{slack}^{\min} \le PG_{slack} \le PG_{slack}^{\max}; \quad QG_i^{\min} \le QG_i \le QG_i^{\max}, \quad i \in Ng,$$

$$VL_i^{\min} \le VL_i \le VL_i^{\max}, \quad i \in NL, \quad T_i^{\min} \le T_i \le T_i^{\max}, \quad i \in NT,$$

$$QC^{\min} \le QC \le QC^{\max}, \quad i \in NC, \quad \left|SL_i\right| \le SL_i^{\max}, \quad i \in NTL,$$

$$VG_i^{\min} \le VG_i \le VG_i^{\max}, \quad i \in Ng.$$

Multi objective fitness function:

$$MOF = F_1 + r_i F_2 + u F_3 =$$

$$= F_1 + \left[\sum_{i=1}^{NL} x_v \left[VL_i - VL_i^{\min}\right]^2 + \sum_{i=1}^{Ng} r_g \left[QG_i - QG_i^{\min}\right]^2\right] + r_f F_3,$$

u is dependent variables;

$$VL_i^{\min} = \begin{cases} VL_i^{\max}, VL_i > VL_i^{\max}; \\ VL_i^{\min}, VL_i < VL_i^{\min}, \end{cases} \qquad QG_i^{\min} = \begin{cases} QG_i^{\max}, QG_i > QG_i^{\max}; \\ QG_i^{\min}, QG_i < QG_i^{\min}. \end{cases}$$

Basketball league algorithm. In this paper BL algorithm has been modelled based on the actions of BL squad. Basketball is a squad game between two teams. The fundamental aim of the game is to notch points by positioning the ball inside the loop and to prevent the opposite squad to score the points. Basketball play starts at the middle of the courtyard once the ball is flung tall up by the umpire and single player from every team contending to increase control. The league team that clasps the ball is called the attacking squad whereas the side not on the ball is the apologetic squad.

Basketball league game characteristically entails of 4 quarters and quarter duration is ten minutes. Subsequently double quarters the squads shift sides on the courtyard. The squad with extra points at the conclusion of the 4 quarters triumphs the competition. If the total is tied at the conclusion of ruling time, the play will be preceded to additional time period. Figure 1 shows the image of basketball court[1].

Fig. 1. An image of basketball court

A bellicose competitor can possess the ball stirring round the court by drooling or fleeting the basketball to a co-player. In a ball drool, a competitor requests to rebound the basketball counter to the base incessantly practice single hand in a period. Using the both hands concurrently drool the basketball two times previously it rebounds on one occasion establishes a twofold drool defilement, which finishes in relinquishing control to the rival squad. Basketball team possess 12 players, with 5 players on the courtyard with limitless replacements are permissible. Players in BL are alienated into consistently fragmented squads grounded upon age, capability, and proficiency. Elucidation has been generated grounded on the squad, players, trainer, and replacement approach. Principally fitness utility for every solution will be calculated and the consequence of competition amongst any two squads playing in BL is anonymous; some squad can triumph at the conclusion. Obviously when squad "*i*" win over squad "*j*" it's owed to the influence of the winning squad correspondingly it will be pathetic point for the dropping squad. Initial solution of the problem is engendered and squads are initialized contingent on the creation of the squad with strategies.

At that time the initial squad is represented as Basketball squad[0] with the populace of number of squads. Initial period B_j^c, B_j^s of the *j*-th variable is demarcated by:

$$B_j^c = \min{}_j + R(\ )(\max{}_j - \min{}_j); \quad B_j^s = \min{}_j + R(\ )(\max{}_j - \min{}_j).$$

Here B_j^c, B_j^s are squad creation and substitution; R is random; min, max indicate lower and upper limits.

[1] Available at: https://www.istockphoto.com/illustrations/basketball-hoop-from-above (accessed: 08.10.2021).

At that point the creation and substitution formation is represented in the form of matrix

$$c=\begin{bmatrix} B_{1,1}^{c} & \cdots & B_{1,j}^{c} \\ \vdots & \ddots & \vdots \\ B_{i,1}^{c} & \cdots & y_{i,j}^{c} \end{bmatrix}; \quad s=\begin{bmatrix} B_{1,1}^{s} & \cdots & B_{1,j}^{s} \\ \vdots & \ddots & \vdots \\ B_{i,1}^{s} & \cdots & B_{i,j}^{s} \end{bmatrix}.$$

Customarily there will be a game with respect to fixture and every squad "*i*" creation demarcated as B_i^c and the forte file is defined as:

$$\vartheta(i)=\frac{fi\left(B_i^c\right)}{\text{Total}\, fi}, \tag{1}$$

$$\text{Total}\;\; fi=\sum_{i=1}^{n} fi\left(B_i^c\right), \tag{2}$$

where *fi* specify the fitness value.

Once 2 squads; *j* and *l* are playing a competition with creations B_i^c and B_l^c then the forte file rate of the squads will be calculated as:

$$\vartheta(j)=\frac{fi\left(B_j^c\right)}{\text{Total}\, fi}; \quad \vartheta(l)=\frac{fi\left(B_l^c\right)}{\text{Total}\, fi}.$$

Possibility for the squad "*j*" to triumph the competition is defined as:

$$py(j,l)=\frac{\vartheta(j)}{\vartheta(j)+\vartheta(l)}.$$

Possibility of the competition between the squads "*l*" and "*j*" is defined as:

$$py(j,l)+py(l,j)=1.0; \quad py(l,j)=1.0-\frac{\vartheta(j)}{\vartheta(j)+\vartheta(l)}.$$

Then the competition between squad "*j*" and "*l*" procedure is:

a. F. competition (*j*, *l*)
b. Calculate $\vartheta(j)$
c. Compute Total *fi*
d. Formula (1)
e. Formula (2)
f. if $py<r$; then
g. Squad "*j*" will be the champion and squad "*l*" will be the loser of the competition

h. Or else

i. Squad "*l*" will be the champion and team "*j*" will be the loser of the competition

j. End if

k. Employ the captivating scheme for the champion

l. Employ the trailing scheme for the failed squad

m. End

Trainers are playing principal part in providing effective contribution to the squad. Correspondingly trainers modify the strategies throughout the competition in the direction of competition wining and it defined as:

$$B_j^c\left(t+1\right)=B_j^c\left(t\right)+R_1\lambda^f\left(\max{}_j-\min{}_j\right); \tag{3}$$

$$B_j^s\left(t+1\right)=B_j^s\left(t\right)+r_1\lambda^s\left(\max{}_j-\min{}_j\right). \tag{4}$$

Strategies given to the squad is defined as:

$$N_{Strategies}=\left[sum\ \ of\ positions\left(j\right)\delta_{Strategies}\right].$$

Strategies sharing technique is defined as:

a. For $k=1:N_{Strategies}$

b. Elect capriciously a location

c. Creation of location — modernization of "*j*"

d. Formula (3)

e. Substitution of position — modernization of "*j*"

f. Formula (4)

g. End for

h. End

In a squad transposition of the players in the competition is applied to elevate the performance:

$$N_{Transposition}=\left[sum\ \ of\ positions\left(j\right)\delta_{Transposition}\right].$$

Successively after selecting two possible location i and j then dual variables U and V with two ways of creation and substitution is defined as:

$$U^c=B_i^c; \tag{5}$$

$$U^s=B_i^s; \tag{6}$$

$$V^c=B_j^c; \tag{7}$$

$$V^s=B_j^s. \tag{8}$$

At that moment:

$$B_i^c = V^c; \tag{9}$$

$$B_i^s = V^s; \tag{10}$$

$$B_j^c = U^c; \tag{11}$$

$$B_j^s = U^s. \tag{12}$$

Then then transposition is defined as:

a. For $k = 1 : N_{Transposition}$
b. Locations "*i*" and "*j*" are capriciously selected
c. Formula (5)
d. Formula (6)
e. Formula (7)
f. Formula (8)
g. Location "*i*" and "*j*" are retreated by
h. Formula (9)
i. Formula (10)
j. Formula (11)
k. Formula (12)
l. End

There will be replacement in squads after each competition:

$$N_s = \left[R\,position(j) \right]. \tag{13}$$

The substitution process is defined as:

a. Calculate the quantity of substitution
b. Formula (13)
c. Designate the collections
d. For $k = 1 : N_s$
e. $B^c_{h(notion)} = s(notion)$
f. $B^s_{h(notion)} = c(notion)$
g. End

Triumphant squad will notice the location within the examination space and it demarcated scientifically by comprising inertia weight ω:

$$B^c(t+1) = B^c(t) + R_1(\omega^c)\left(B^c(t)^* - B^c(t)\right);$$
$$B^s(t+1) = B^s(t) + R_1(\omega^s)\left(B^s(t)^* - B^s(t)\right).$$

In any squad erudition segment is significant and it significantly progress the performance: $\varepsilon = eaR_1 - g;\ h = eR_2;\ g = \beta - (t(\beta / t_{\max}))$, then

$$B_j^p(t+1)_\mu = \left(B_j^p(t)\right)_\mu - \varepsilon\left(\left|h\left(B_j^p(t)\right)_\mu - \left(B_j^p(t)\right)\right|\right).$$

Uppermost 3 squads in the points table will own the virtuous superiority of erudition

$$B_j^c(t+1)_1 = \left(B_j^c(t)\right)_1 - \varepsilon\left(\left|h\left(B_j^c(t)\right)_1 - \left(B_j^c(t)\right)\right|\right); \tag{14}$$

$$B_j^c(t+1)_2 = \left(B_j^c(t)\right)_2 - \varepsilon\left(\left|h\left(B_j^c(t)\right)_2 - \left(B_j^c(t)\right)\right|\right); \tag{15}$$

$$B_j^c(t+1)_3 = \left(B_j^c(t)\right)_3 - \varepsilon\left(\left|h\left(B_j^c(t)\right)_3 - \left(B_j^c(t)\right)\right|\right). \tag{16}$$

With orientation to the premium squad assets the present solution upgrading is done:

$$B_j^s(t+1)_1 = \left(B_j^s(t)\right)_1 - \varepsilon\left(\left|h\left(B_j^s(t)\right)_1 - \left(B_j^s(t)\right)\right|\right); \tag{17}$$

$$B_j^s(t+1)_2 = \left(B_j^s(t)\right)_2 - \varepsilon\left(\left|h\left(B_j^s(t)\right)_2 - \left(B_j^s(t)\right)\right|\right); \tag{18}$$

$$B_j^s(t+1)_3 = \left(B_j^s(t)\right)_3 - \varepsilon\left(\left|h\left(B_j^s(t)\right)_3 - \left(B_j^s(t)\right)\right|\right); \tag{19}$$

$$B_j^s(t+1) = \frac{B_j^s(t+1)_1 + B_j^s(t+1)_2 + y_j^s(t+1)_3}{3}. \tag{20}$$

Players are moved to various squads and it defined as:

$$N_{st} = \left[N\ \%\ \text{of squads take part in cyclical transference}\right].$$

The cyclic transfer is defined as:

a. For $k = 1 : N_{Cyclic\ transfer}$
b. $Ct = \{\text{select rand index } i \text{ from} \,|\, i \neq Ct\}$
c. End for
d. For $k = 1$ to $N\_(Ct)$
e. For $j = 1$ to j
f. if $rand > 0.5$
g. $ct_j^c(notion) = q_j^c$

h. $ct_j^s(notion) = q_j^s$
i. q = select arbitrarily for current squads
j. End if
k. End for
l. $cf(notion) = fi\left(B^c(notion)\right)$
m. End for
n. End

Rendering to the performance in the specific period elevation and relegation of the squads will be present. Supremely accomplished squads will be endorsed to eldest competition and deprived performed squad will be downgraded to junior division league:

$$N_{Squads\ move} = \left[\text{sum of squads } \delta_{Squads\ moved\ to\ alternative\ league}\right].$$

Elevation and relegation procedure is defined as:
a. Eradicate poorest squads $N_{Squads\ move}$
b. Define the creation and substitution
c. For $k = 1 : N_{Squads\ move}$
a. For $j = 1$ to j
d. $Nsquads_j^c(notion) = Z_j^c$
e. $Nsquads_j^s(notion) = Z_j^s$
f. End for
g. $cf(notion) = f\left(Nsquads^c(notion)\right)$
h. End for
i. Add number of teams to the league
j. End

The overall procedure of the BL algorithm as follows:
a. Start
b. Initialize the variables
c. Identify the premium Basketball squad period
d. $Nperiod = Nperiod + 1,\ i = 1$
e. Stimulate the league schedule
f. Competition amongst squads
i. F. Competition (j, l)
ii. Calculate $\vartheta(j)$
iii. Compute total fi

iv. Formula (1)
v. Formula (2)
vi. if $py < r$; then
vii. Squad "*j*" will be the champion and squad "*l*" will be the loser of the competition
viii. Or else
ix. Squad "*l*" will be the champion and team "*j*" will be the loser of the competition
x. End if
xi. Employ the captivating scheme for the champion
xii. Employ the trailing scheme for the failed squad
xiii. End

g. Strategies sharing technique

i. For $k = 1 : N_{Strategies}$
ii. Elect capriciously a location
iii. Creation of location — modernization of "*j*"
iv. Formula (3)
v. Substitution of position — modernization of "*j*"
vi. Formula (4)
vii. End for
viii. End

h. Forte index calculated for squads

i. Apply transposition procedure

i. For $k = 1 : N_{Transposition}$
ii. Locations "*i*" and "*j*" are capriciously selected
iii. Formula (5)
iv. Formula (6)
v. Formula (7)
vi. Formula (8)
vii. Location "*i*" and "*j*" are retreated by
viii. Formula (9)
ix. Formula (10)
x. Formula (11)
xi. Formula (12)
xii. End

j. The Substitution process is defined as

i. Calculate the quantity of substitution
ii. Formula (13)

iii. Designate the collections

iv. For $k = 1 : N_s$

v. $B^c_{h(notion)} = s(notion)$

vi. $B^s_{h(notion)} = c(notion)$

vii. End

k. Champion and loser are defined

l. Uppermost 3 squads in the points table will own the virtuous superiority of erudition

i. Formula (14)

ii. Formula (15)

iii. Formula (16)

m. With orientation to the premium squad assets the present solution upgrading is done

i. Formula (17)

ii. Formula (18)

iii. Formula (19)

iv. Formula (20)

n. Smearing altered strategies

o. Renewal of premium squad

p. Erudition segment will be employed

q. If max No. of week = N weeks

r. Yes, then erase the poorly performed squads

s. Or else go to step e

t. Include fresh squad to the BL

u. Smear the transferal procedure

i. For $k = 1 : N_{Cyclic\ transfer}$

ii. $Ct = \{\text{select rand index } i \text{ from} \,|i \neq Ct\}$

iii. End for

iv. $k = 1 \text{ to} N\_(Ct)$

v. For $j = 1$ to j

vi. if rand > 0.5

vii. $ct^c_j(notion) = q^c_j$

viii. $ct^s_j(notion) = q^s_j$

ix. q = select arbitrarily for current squads

xi. End if

xii. End for

xiii. $cf\ (notion) = fi\left(B^c\ (notion)\right)$

xiv. End for

xv. End

v. Transformation of the preeminent squad

w. max N period = N period

x. Yes, then define the premium solution

y. Or else go to step d

z. End

The offline inaccuracy is computed by

$$Offline\ \ inaccuracy =$$
$$= \frac{1}{\text{Maximum iteration}} \sum_{t=1}^{\text{Maximum iteration}} Present\ \ inaccuracy_t .$$

The computation complexity is a metric key for BL algorithm to comprehend its running time. It is influenced by the quantity of maximum iterations, summation of variables, and addition of other parameters in iterations. By reason of quicksort algorithm is realized, the sort's computation complication of $O(nlogn)$ and $O\left(n^2\right)$ in the finest and least case respectively. The generalized total calculation of complexity is apportioned as follows:

$$O(nlogn) = O\left(T\left(O(s) + O(p)\right)\right);$$
$$O\left(n^2\right) = O\left(t\left(n^2 + nd\right)\right) = O\left(tn^2 + tnd\right).$$

Simulation results and discussion. Projected BL algorithm is corroborated in IEEE 30 bus system [20]. Table 1 shows the real loss appraisal, Table 2 shows the voltage aberration evaluation and Table 3 gives the voltage constancy assessment. Figure 2 give the graphical appraisal between the methods. BL abridged the power loss efficiently. Appraisal of loss has been done with particle swarm optimization (PSO), adapted PSO, enriched PSO, comprehensive learning PSO, adaptive genetic algorithm (GA), canonical GA, enhanced GA, hybrid PSO-Tabu search (PSOTS), ant lion approach (ALO), quasi-oppositional teaching learning based algorithm (QOTLBO), enriched stochastic fractal search optimization algorithm, harmony search, advanced pseudo-gradient search PSO and cuckoo search algorithm. Power loss abridged competently and proportion of the power loss lessening has been enhanced. Predominantly voltage constancy augmentation attained with minimized voltage deviancy.

Table 1

Assessment of real power loss

Algorithm	Power loss, MW	Algorithm	Power loss, MW
Hybrid-PSOTS [10]	4.5213	B-PSO [13]	4.9239
B-TS [10]	4.6862	Hybrid-AS [13]	4.9059
S-PSO [10]	4.6862	B-FS [14]	4.5777
B-ALO [11]	4.5900	Hybrid-ISFS [14]	4.5142
Hybrid-QOTLBO [12]	4.5594	B-FS [16]	4.5275
B-TLBO [12]	4.5629	BL	4.4012
S-GA [13]	4.9408		

Table 2

Comparison of voltage deviancy

Algorithm	Voltage deviancy, PU	Algorithm	Voltage deviancy, PU
Hybrid-PSOTVIW [15]	0.1038	Hybrid-MPGPSO [15]	0.0892
Hybrid-PSOTVAC [15]	0.2064	Hybrid-QOTLBO [12]	0.0856
Hybrid-PSOTVAC [15]	0.1354	B-TLBO [12]	0.0913
Hybrid-PSOCF [15]	0.1287	B-FS [14]	0.1220
Hybrid-PGPSO [15]	0.1202	Hybrid-ISFS [14]	0.0890
Hybrid-SWTPSO [15]	0.1614	B-FS [16]	0.0877
Hybrid-PGSWTPSO [15]	0.1539	BL	0.0824

Table 3

Appraisal of voltage constancy

Algorithm	Voltage constancy (L-index), PU	Algorithm	Voltage constancy (L-index), PU
Hybrid-PSOTVIW [15]	0.1258	B-TLBO [12]	0.1180
Hybrid-PSOTVAC [15]	0.1499	B-ALO [11]	0.1161
Hybrid-PSOTVAC [15]	0.1271	B-ABC [11]	0.1161
Hybrid-PSOCF [15]	0.1261	B-GWO [11]	0.1242
Hybrid-PGPSO [15]	0.1264	B-BA [11]	0.1252
Hybrid-SWTPSO [15]	0.1488	B-FS [14]	0.1252
Hybrid-PGSWTPSO [15]	0.1394	Hybrid-ISFS [14]	0.1245
Hybrid-MPGPSO [15]	0.1241	B-FS [16]	0.1007
Hybrid-QOTLBO [12]	0.1191	BL	0.1001

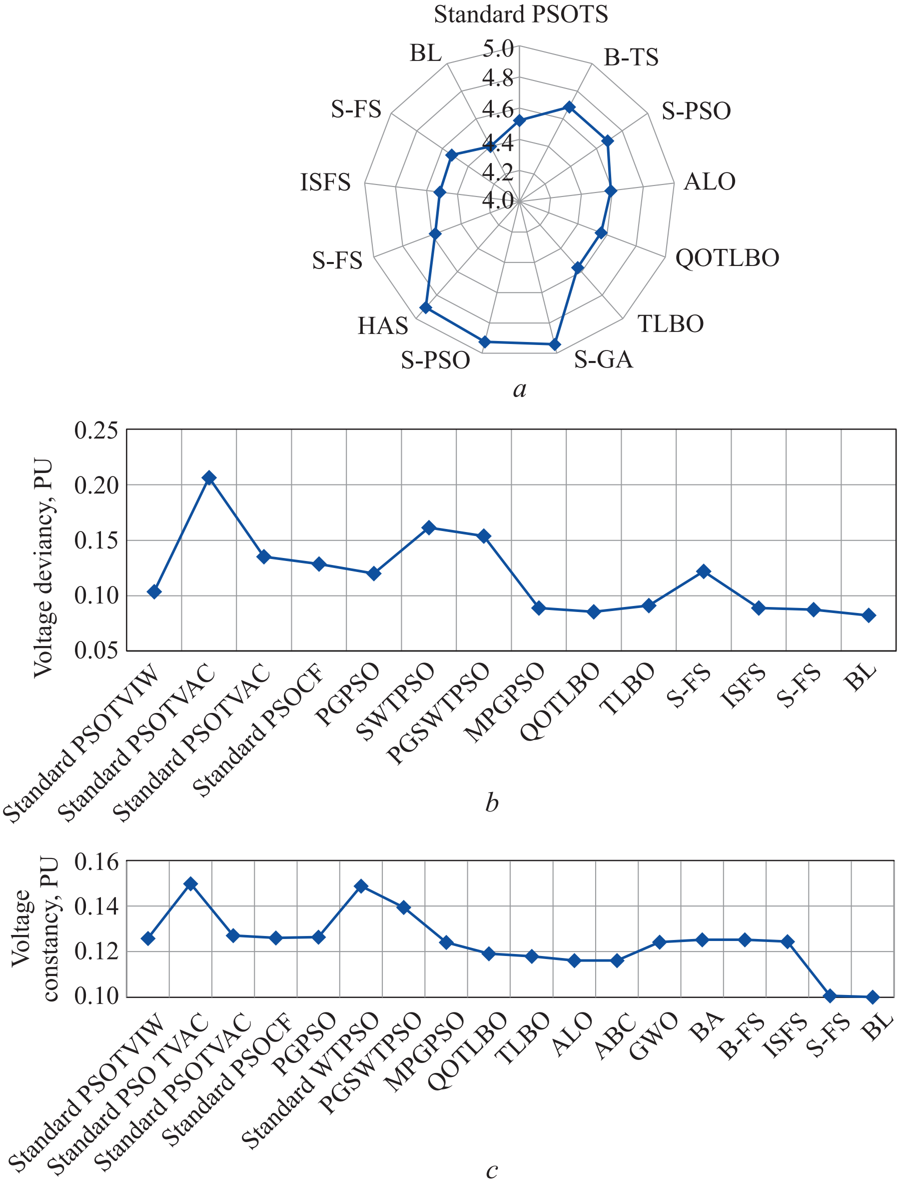

Fig. 2. Assessment of real power loss (*a*), appraisal of voltage deviancy (*b*) and assessment of voltage constancy index (*c*)

Then the BL algorithm is substantiated in IEEE 14, 30, 57, 118 and 300 bus test systems deprived of voltage constancy. Loss appraisal is shown in Tables 4, 5. Figures 3, 4 give graphical comparison between the approaches with orientation to power loss. Proposed algorithms are compared with adapted PSO, PSO, evolutionary programming, self-adaptive real coded GA, canonical GA, adaptive GA, enhanced PSO, comprehensive learning PSO, enhanced GA, faster evolutionary algorithm (EA) and cuckoo search optimization (CSO) algorithm.

Table 4

Assessment of results

Algorithm	True power loss, MW	Ratio of loss diminution
IEEE 14 bus system		
Base case [24]	13.550	0
Improved PSO [24]	12.293	9.200
B-PSO [23]	12.315	9.100
B-EP [23]	13.346	1.500
Hybrid-SARGA [22]	13.216	2.500
BL	10.019	26.059
IEEE 57 bus system		
Base case [24]	27.8	0
Improved PSO [24]	23.51	15.400
B-PSO [23]	23.86	14.100
Canonical-GA[22]	25.24	9.200
Adaptive-GA [22]	24.56	11.600
BL	21.016	24.4028
IEEE 118 bus system		
Base case [24]	132.800	0
Improved PSO [24]	117.190	11.700
B-PSO [23]	119.340	10.100
B-EPSO [21]	131.990	0.6000
B-CLPSO [21]	130.960	1.3000
BL	112.002	15.6611

Table 5

Appraisal of loss (IEEE 30 bus system)

Algorithm	Actual power loss, MW	Proportion of lessening in power loss
Base case value [24]	17.5500	0
Improved PSO[24]	16.0700	8.40000
B-PSO [23]	16.2500	7.4000
B-EP [21]	16.3800	6.60000
B-GA [22]	16.0900	8.30000
S-PSO [25]	17.5246	0.14472
Improved DEPSO [25]	17.5200	0.17094
B-JAYA [25]	17.5360	0.07977
BL	14.0180	20.1253

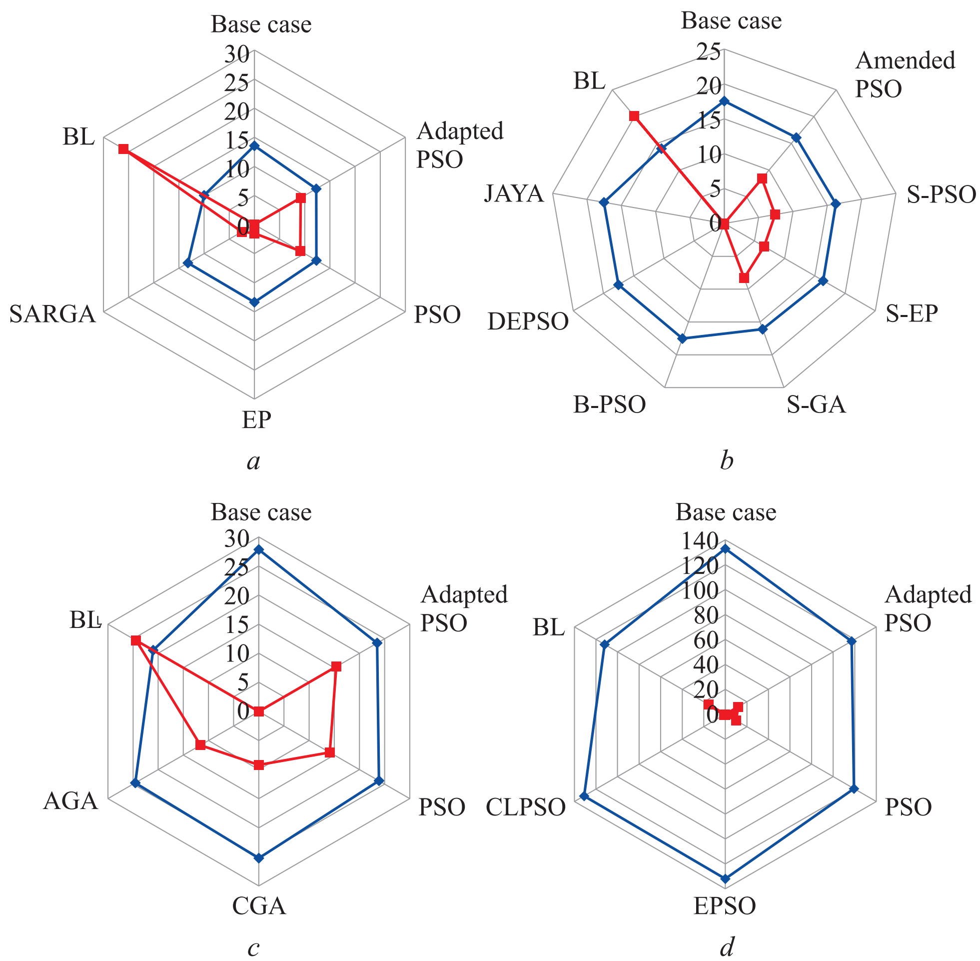

Fig. 3. Power loss appraisal:
a) IEEE 14 bus system (◆ true power loss; ■ ratio of loss diminution);
b) IEEE 30 bus system (◆ true power loss; ■ proportion of lessening in power loss);
c) IEEE 57 bus system (◆ true power loss; ■ ratio of loss diminution);
d) IEEE 118 bus system (◆ true power loss; ■ ratio of loss diminution)

True power loss, MW, appraisal (IEEE 300 bus system):

Adaptive-GA [31] 646.299800
Faster-EA [31] 650.602700
B-CSO [32] 635.894200
BL algorithm 625.090877

The convergence characteristics of BL algorithm for IEEE 30 bus system show bellow:

Actual loss with / without power reliability, MW .... 4.4012 / 14.018
Time with / without power reliability, s .... 26.13 / 23.91
Number of iterations with / without power reliability .... 27 / 22

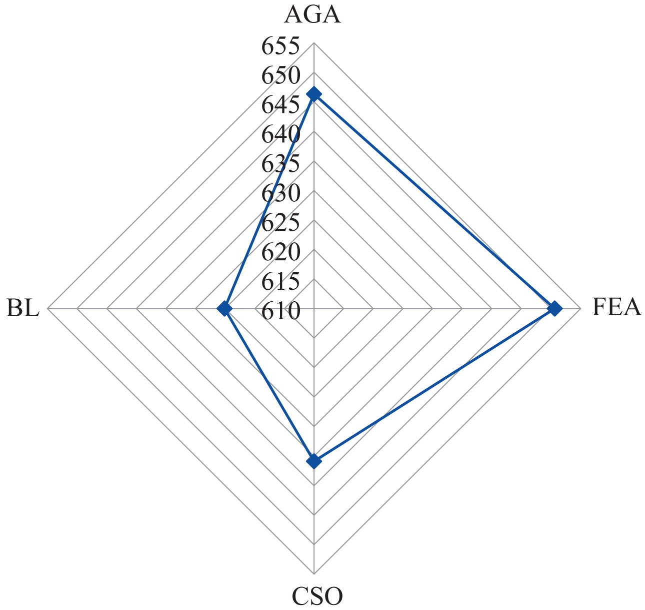

Fig. 4. True power loss, MW, appraisal (IEEE 300 bus system)

In IEEE 30 bus BL algorithm been evaluated as multiobjective and single objective mode. Figure 5 shows the graphical representation of the characteristics.

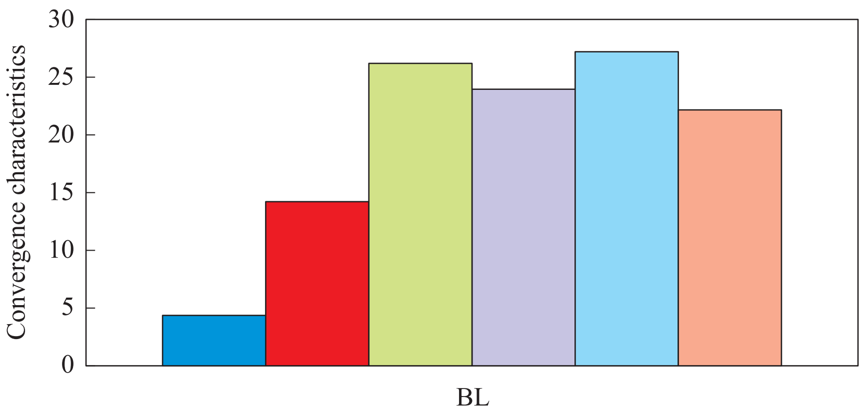

Fig. 5. Convergence characteristics:
actual power loss with (■) or without (■) voltage constancy; time with (■) or without (■) voltage constancy; number of iterations with (■) or without (■) voltage constancy

Conclusion. Basketball League algorithm reduced the genuine power loss competently. Proposed algorithm is corroborated in IEEE 30 bus system and IEEE 14, 30, 57, 118, 300 bus test systems without considering the voltage constancy index. True power loss lessening, voltage divergence curtailing, and voltage constancy index augmentation has been attained. Basketball League game characteristically entails of 4 quarters and quarter duration is ten minutes. Subsequently double quarters the squads shift sides on the courtyard. The squad with extra points at the conclusion of the 4 quarters triumphs the competition. If the total is tied at the conclusion of ruling time, the play will be preceded to additional time period. A bellicose competitor can possess the ball stirring round the court by drooling or fleeting the basketball to a co-player. In a ball drool, a competitor requests to rebound the basketball counter to the base incessantly practice single hand in a period. Using the both hands concurrently drool the basketball two times previously it rebounds on one occasion establishes a twofold drool defilement, which finishes in relinquishing control to the rival squad. Basketball League algorithm creditably condensed the power loss and proportion of Actual power loss lessening has been elevated. Trainers are playing principal part in providing effective contribution to the squad. Correspondingly trainers modify the strategies throughout the competition in the direction of competition wining. Rendering to the performance in the specific period elevation and relegation of the squads will be present. Supremely accomplished squads will be endorsed to eldest competition and deprived performed squad will be downgraded to junior division league. Convergence characteristics show the better performance of the proposed BL algorithm. Valuation of power loss has been done with other customary reported algorithms.

REFERENCES

[1] Zhu J.Z., Xiong X.F. Optimal reactive power control using modified interior point method. *Electr. Power Syst. Res.*, 2003, vol. 66, iss. 2, pp. 187–192.
DOI: https://doi.org/10.1016/S0378-7796(03)00078-6

[2] Quintana V.H., Santos-Nieto M. Reactive-power dispatch by successive quadratic programming. *IEEE Trans. Energy Convers.*, 1989, vol. 4, iss. 3, pp. 425–435.
DOI: https://doi.org/10.1109/60.43245

[3] Jan R.-M., Chen N. Application of the fast Newton — Raphson economic dispatch and reactive power/voltage dispatch by sensitivity factors to optimal power flow. *IEEE Trans. Energy Convers.*, 1995, vol. 10, iss. 2, pp. 293–301.
DOI: https://doi.org/10.1109/60.391895

[4] Terra L.D.B., Short M.J. Security-constrained reactive power dispatch. *IEEE Trans. Power Syst.*, 1991, vol. 6, iss. 1, pp. 109–117. DOI: https://doi.org/10.1109/59.131053

[5] Grudinin N. Reactive power optimization using successive quadratic programming method. *IEEE Trans. Power Syst.*, 1998, vol. 13, iss. 4, pp. 1219–1225.
DOI: https://doi.org/10.1109/59.736232

[6] Ebeed M., Alhejji A., Kamel S., et al. Solving the optimal reactive power dispatch using marine predators algorithm considering the uncertainties in load and wind-solar generation systems. *Energies*, 2020, vol. 13, iss. 17, art. 4316.
DOI: https://doi.org/10.3390/en13174316

[7] Sahli Z., Hamouda A., Bekrar A., et al. Reactive power dispatch optimization with voltage profile improvement using an efficient hybrid algorithm. *Energies*, 2018, vol. 11, iss. 8, art. 2134. DOI: https://doi.org/10.3390/en11082134

[8] Davoodi E., Babaei E., Mohammadi-Ivatloo B., et al. A novel fast semidefinite programming-based approach for optimal reactive power dispatch. *IEEE Trans. Industr. Inform.*, 2020, vol. 16, iss. 1, pp. 288–298.
DOI: https://doi.org/10.1109/TII.2019.2918143

[9] Bingane C., Anjos M.F., Le Digabel S. Tight-and-cheap conic relaxation for the optimal reactive power dispatch problem. *IEEE Trans. Power Syst.,* 2019, vol. 34, iss. 6, pp. 4684–4693. DOI: https://doi.org/10.1109/TPWRS.2019.2912889

[10] Sahli Z., Hamouda A., Bekrar A., et al. Hybrid PSO-tabu search for the optimal reactive power dispatch problem. *IECON*, 2014, pp. 3536–3542.
DOI: https://doi.org/10.1109/IECON.2014.7049024

[11] Mouassa S., Bouktir T., Salhi A. Ant lion optimizer for solving optimal reactive power dispatch problem in power systems. *Eng. Sci. Technol. an Int. J.*, 2017, vol. 20, iss. 3, pp. 885–895. DOI: https://doi.org/10.1016/j.jestch.2017.03.006

[12] Mandal B., Roy P.K. Optimal reactive power dispatch using quasi-oppositional teaching learning based optimization. *Int. J. Electr. Power Energy Syst.*, 2013, vol. 53, pp. 123–134. DOI: https://doi.org/10.1016/j.ijepes.2013.04.011

[13] Khazali H., Kalantar M. Optimal reactive power dispatch based on harmony search algorithm. *Int. J. Electr. Power Energy Syst.*, 2011, vol. 33, iss. 3, pp. 684–692.
DOI: https://doi.org/10.1016/j.ijepes.2010.11.018

[14] Tran H.V., Pham T.V., Pham L.H., et al. Finding optimal reactive power dispatch solutions by using a novel improved stochastic fractal search optimization algorithm. *TELKOMNIKA*, 2019, vol. 17, no. 5, pp. 2517–2526.
DOI: http://doi.org/10.12928/telkomnika.v17i5.10767

[15] Polprasert J., Ongsakul W., Dieu V.N. Optimal reactive power dispatch using improved pseudo-gradient search particle swarm optimization. *Electr. Power Compon. Syst.*, 2016, vol. 44, iss. 5, pp. 518–532.
DOI: https://doi.org/10.1080/15325008.2015.1112449

[16] Duong T.L., Duong M.Q., Phan V.-D., et al. Optimal reactive power flow for large-scale power systems using an effective metaheuristic algorithm. *J. Electr. Comput. Eng.*, 2020, vol. 2020, art. 6382507. DOI: https://doi.org/10.1155/2020/6382507

[17] Grundman A.H. The golden age of amateur basketball. University of Nebraska Press, 2004.

[18] Brown D.H. A basketball handbook. AuthorHouse, 2007.

[19] Forrest C.A. All you wanted to know about basketball. Sterling Publ., 1991.

[20] Illinois Center for a Smarter Electric Grid (ICSEG).
Available at: https://icseg.iti.illinois.edu (accessed: 06.08.2023).

[21] Dai C., Chen W., Zhu Y., et al. Seeker optimization algorithm for optimal reactive power dispatch. *IEEE Trans. Power Syst*., 2009, vol. 24, iss. 3, pp. 1218–1231.
DOI: https://doi.org/10.1109/TPWRS.2009.2021226

[22] Subbaraj P., Rajnarayan P.N. Optimal reactive power dispatch using self-adaptive real coded genetic algorithm. *Electr. Pow. Syst. Res*., 2009, vol. 79, iss. 2, pp. 374–381. DOI: https://doi.org/10.1016/j.epsr.2008.07.008

[23] Pandya S., Roy R. Particle swarm optimization based optimal reactive power dispatch. *Proc. ICECCT*, 2015. DOI: https://doi.org/10.1109/ICECCT.2015.7225981

[24] Hussain A.N., Abdullah A.A., Neda O.M. Modified particle swarm optimization for solution of reactive power dispatch. *Res. J. Appl. Sci. Eng. Technol*., 2018, vol. 15, iss. 8, pp. 316–327. DOI: http://dx.doi.org/10.19026/rjaset.15.5917

[25] Vishnu M., Kumar T.K.S. An improved solution for reactive power dispatch problem using diversity-enhanced particle swarm optimization. *Energies*, 2020, vol. 13, iss. 11, art. 2862. DOI: https://doi.org/10.3390/en13112862

[26] Omelchenko I.N., Lyakhovich D.G., Aleksandrov A.A., et al. Development of a design algorithm for the logistics system of product distribution of the mechanical engineering enterprise. *Herald of the Bauman Moscow State Technical University, Series Mechanical Engineering*, 2020, no. 3 (132), pp. 62–69 (in Russ.).
DOI: https://doi.org/10.18698/0236-3941-2020-3-62-69

[27] Omelchenko I.N., Zakharov M.N., Lyakhovich D.G., et al. [Organization of logistic systems of scientific productions: scientific research work of the master's student and evaluation of its results]. *Sistemy upravleniya polnym zhiznennym tsiklom vysokotekhnologichnoy produktsii v mashinostroenii: novye istochniki rosta. Mater. III Vseros. nauch.-prakt. konf*. [Organisation of Logistics Systems for Knowledge-Intensive Industries: Master's Student Research Work and Evaluation. Proc. III Russ. Sci.-Pract. Conf.]. Moscow, Pervoe ekonomicheskoe izdatelstvo Publ., 2020, pp. 252–256 (in Russ.).
DOI: https://doi.org/10.18334/9785912923258.252-256

[28] Omelchenko I.N., Lyakhovich D.G., Aleksandrov A.A., et al. [Problems and organizational and technical solutions of processing management problems of material and technical resources in a design-oriented organization]. *Sistemy upravleniya polnym zhiznennym tsiklom vysokotekhnologichnoy produktsii v mashinostroenii: novye istochniki rosta. Mat. III Vseros. nauch.-prakt. konf*. [Management systems for the full life cycle of high-tech products in mechanical engineering: new sources of growth. Mat. III All-Russ. Sci. Pract. Conf.]. Moscow, Pervoe ekonomicheskoe izdatelstvo Publ., 2020, pp. 257–260 (in Russ.). DOI: https://doi.org/10.18334/9785912923258.257-260

[29] Khunkitti S., Siritaratiwat A., Premrudeepreechacharn S. Multi-objective optimal power flow problems based on slime mould algorithm. *Sustainability*, 2021, vol. 13, iss. 13, art. 7448. DOI: https://doi.org/10.3390/su13137448

[30] Diab H., Abdelsalam M., Abdelbary A. A multi-objective optimal power flow control of electrical transmission networks using intelligent meta-heuristic optimization techniques. *Sustainability*, 2021, vol. 13, iss. 9, art. 4979.
DOI: https://doi.org/10.3390/su13094979

[31] Surender R.S. Optimal reactive power scheduling using cuckoo search algorithm. *IJECE*, 2017, vol. 7, no. 5, pp. 2349–2356.
DOI: http://doi.org/10.11591/ijece.v7i5.pp2349-2356

[32] Reddy S.S. Faster evolutionary algorithm based optimal power flow using incremental variables. *Int. J. Electr. Power Energy Syst.*, 2014, vol. 54, pp. 198–210.
DOI: https://doi.org/10.1016/j.ijepes.2013.07.019

Kanagasabai Lenin — Dr. Sc. (Full), Professor, Department of Electrical and Electronics Engineering, Prasad V. Potluri Siddhartha Institute of Technology (Kanuru, Vijayawada, Andhra Pradesh, 520007 India).

Please cite this article as:

Kanagasabai L. Real power loss reduction by Basketball League algorithm. *Herald of the Bauman Moscow State Technical University, Series Natural Sciences*, 2024, no. 3 (114), pp. 92–114. EDN: RGSEIK