AN ELEGANT SOLUTION METHOD FOR SEARCHING OPTIMALITY IN POWER SYSTEM

S. Sakthi
Research Scholar
Department of EEE
College of Engineering, Guindy
Anna University, Chennai
Correspondance: sakthis0703@gmail.com

Dr. V. Senthilkumar
Professor
Department of EEE
College of Engineering, Guindy
Anna University, Chennai
Correspondance: sensang@annauniv.edu

Abstract: *Optimal power flows justify the whole operational planning and operation of power system. Optimal control settings as active power generations, Voltages of all generators, optimal setting of transformer and compensators with a view of minimization of one or more objective functions such as fuel cost, losses, etc. It is a constrained optimization problem statement; it can be solved by traditional mathematical techniques. These techniques grieve from the drawback of landing at sub-optimal solution and difficulties in handling non-differentiable and discontinuous functions. The development of Evolutionary algorithms such as GA, PSO, EP, etc. has tried to overcome the drawbacks. Recently, Flower Pollination Algorithm (FPA), a nature-intriguing algorithm works based on the characteristics off lowering plants. Its evolutionary characteristics can be utilized to determine a solution methodology for optimal power flow. This paper extends to develop a Flower Pollination Algorithm based methodology for solving Optimal Power Flow with a view to obtain the global best solution and presents the results on IEEE 30 bus system to display its effectiveness*

1. Introduction:

In present scenario the growth in the power demand keep on increasing in nature, It is has forced the power system engineers to develop smart grid systems interconnecting various generating stations located at various locations. Now a day's power system is typically a very multi area inter-connected system consists of generating stations. To meet this growing demand, Construction of new transmission lines or further increase of generating capacity having limitations, as referred to this power flow through the transmission line congested. Voltages are being dropped, lines gets overloaded.

The optimal real and reactive power flow (OPF) has been broadly utilized in power system operation to find optimal operational settings for particular control variables by optimizing the objective functions when satisfying a set of equality and inequality constraints. In optimal power, problem cost is the major consideration. Due to cost is the main factor losses in the line is the second consideration. So the voltage is be maintain constant as well as stability have to be maintain [9] Presented a solution methodologies for OPF Problem Particle Swarm Optimization (PSO) obtains a universal solution. [7], [3] given outline about the modified strategy for OPF along with radial distribution system. This approach explores an optimal location of shunt capacitors thereby improving the power factor and voltage enhancement. [8] Explained the losses being reduced by load balancing with those voltages are increased and losses reduced [6] explained an exclusive OPF Algorithm with formulated a viable approach for Stochastic OPF analysis. This method revolves the boundary space for stability even during contingency conditions. .[13] presented an adaptive technique which makes decreased fuel cost, loss, and improved voltage profile [11] Explained as that of improvement of all the parameters in power system in optimization. The method seems to have quick convergence characteristics.

The literature review shows that there is a thrust in the area on a great deal of investigation in the area of optimal operation of power systems in order to achieve the desired performances such as minimization of fuel cost, reduction of power system loss, steady improvement of voltage profile, enhancement of voltage support, etc. there is a way to find the exact global solution for these complicated optimization problems, there is always a need to develop better methods with a view of obtaining the global best solution.

Computational intelligence Optimization algorithms based on swarm intelligence such as GA, EP, ACO, PSO, BBO and FFO achieved optimal solutions with separate initial solutions and free from differential solutions, and it can hybrid with other solution search optimization algorithm

Many researchers found heuristic algorithms for different kinds of hard-to-solve problems. Dr. Xin-She Yang recently suggested FPA, which is based on the pollination process of flowering plants, for taking care of complex streamlining issues.

2. Formulation

The OPF problem is framed with objective functions and constraints. The constraints are equality, in equality constraints through the generalized representation as follows:

Target 1: Total Fuel Cost

The total fuel cost in the generating units normally explained via quadratic equations because of power output. Total fuel cost can be written as

$$\text{Minimize} \quad J_1(x,u) = \sum_{i=1}^{n} F_i(P_i) \qquad (1)$$

$$F_i(P_i) = a_i P_i^2 + b_i P_i + c_i + |\, d_i * \sin(e_i \times (P_i^{\min} - P_i))| \qquad (2)$$

Where equation (2) inclusion of valve point loading effect

Target 2: **Real Power Loss**

The real power loss objective function can be written as

$$J_2(x,u) = P_L \qquad (3)$$

Where

$$P_L = \sum_{k\in\varphi} g_{ij} \left(|V_i|^2 + |V_j|^2 - 2\,|V_i|\,|V_j| \cos\delta_{ij} \right) \qquad (4)$$

Target 3: **Combination of Fuel cost and Real power loss**

Subject to

$$J^{multi}(x,u) = \sum_{i=1}^{nobjec} w_i\, j_i(x,u)$$

$$g(x,u) = 0 \qquad (5)$$

$$h(x,u) \le 0 \qquad (6)$$

Where x is the vector indicating the power generation on slack bus, VAR capacity generation on generation buses, nature of voltage profile at the load bus. u is the vector expressed a voltage at all the generating buses, OLTC transformer positions, VAR compensators $g(x,u)$ can be written as

$$P_{Gi} - P_{Di} - V_i \sum_{j=1`}^{nb} V_j (G_{ij} \cos\delta_{ij} + B_{ij} \sin\delta_{ij}) = 0 \qquad (7)$$

$$Q_{Gi} - Q_{Di} - V_i \sum_{j=1`}^{nb} V_j (G_{ij} \sin\delta_{ij} - B_{ij} \cos\delta_{ij}) = 0 \qquad (8)$$

The inequality constraints are the voltage at generating bus, tap setting, and VAR generations on compensators and generator bus and the real power generation.

$$P_{Gi}^{\min} \le P_{Gi} \le P_{Gi}^{\max} \qquad (9)$$

$$Q_{Gi}^{\min} \le Q_{Gi} \le Q_{Gi}^{\max} \qquad (10)$$

$$Q_{Ci}^{\min} \le Q_{Ci} \le Q_{Ci}^{\max} \qquad (11)$$

$$T_i^{\min} \le T_i \le T_i^{\max} \qquad (12)$$

$$V_{Gi}^{\min} \le V_{Gi} \le V_{Gi}^{\max} \qquad (13)$$

$$V_{Li}^{\min} \le V_{Li} \le V_{Li}^{\max} \qquad (14)$$

The multi-objective optimal power flow problem is formulated by combination of several functions with proper chosen values of weight factor. Then the problem can be written as

$$\text{Minimize} \quad J^{multi}(x,u) = \sum_{i=1}^{nobj} w_i\; J_i(x,u) \qquad (15)$$

Where w that demonstrate the relative noteworthiness among the picked destinations, usually set as one.

3. Flower Pollination Algorithm

The main aim of the proposed flower pollination algorithm obtaining the best solution on the reproduction of plant in numbers. It can be considered, as species of the plant. It is the process of obtaining the fittest value in the optimal reproduction process.

. Proposed Flower pollination algorithm implemented through the following steps:

Process 1:	Worldwide fertilization depicted by means of biotic and cross-fertilization forms, as dust conveying pollinators fly after Levy flight.
Process 2:	Nearby fertilization described in abiotic and self-fertilization as the procedure does not require any pollinators.
Process 3:	Reproduction probability is based on the two flowers on the similar. Flower constancy may be implemented by insects,
Process 4:	The collaboration of neighborhood and worldwide fertilization is constrained by a switch likelihood , softly one-sided toward nearby fertilization

Let consider here as a plant have only one flower. Each flower can produce one pollen gamete. That, there is no need to distinguish a pollen gamete, a flower, a plant or solution to a problem. x_i Is the factor that is solution to the bloom or a dust gamete.

There are two main process in a proposed algorithm that is the worldwide fertilization and neighborhood fertilization. In the overall preparation step, pollinators, for example, bugs convey bloom dusts, and dusts can go over a long separation since creepy crawlies can regularly fly and move in an any longer range. This ensures the pollination and reproduction of the fittest. Therefore, global pollination step and flower constancy step can be written as:

$$x_l^{t+1} = x_l^t + \gamma\, L(\lambda)\, (x_l^t - g^*) \qquad (16)$$

Where x_l^t - pollen of bloom at t th iteration

g^* Is the current best solution determined from all solutions at the current generations.

γ Is a scaling factor

$L(\lambda)$ is the Levy flights based on the strength of pollination and the step size is taken. On varying the step size, longer distances can be covered. This behavior will work on efficient manner. The value of $L > 0$.

$$L \approx \frac{\lambda\Gamma(\lambda)\sin(\pi\lambda/2)}{\pi}\,\frac{1}{s^{1+\lambda}}, \quad (s >> s_o > 0) \qquad (17)$$

Where $\Gamma(\lambda)$ the standard gamma function and this distribution is implemented when choosing the value of s is greater than zero. local pollination, both process 2 and Process 3 can be considered for analysis

$$x_l^{t+1} = x_l^t + \varepsilon(x_n^t - x_p^t) \qquad (18)$$

Here x_n^t , x_p^t are dust from various blooms of a similar plant animal groups imitating the blossom steadiness in a restricted neighborhood. In a purpose of local random walk, x_n^t and x_p^t comes from the same species. ε taken as uniform distribution as [0,1]

Initial value of P is chosen as 0.5, if the initial process got over then can be changed to 0.8 for the best result for the most of the process

The Proposed Flower Pollination Algorithm as follows:

1) Choose population size, number of iterations, Convergence characteristics switch probability *p*,
2) With the help of random process Initialize a population of NF flowers
3) Determine the objective function of each flower of present population.
4) Evaluate and update the best solution
5) In the present flower in the population, generate a random number in a range of (0, 1). Suppose the number is less than the *p*, perform local pollination; else do global pollination using Levy flight.

6) If the convergence criterian is met print the solutions else repeat the process from step 3
7) End the process.

4. An Elegant Solution Method

Representation of Control Variables

In the power system problem control variables are Power P, Voltage (V) at the generator terminals OLTC Positions. Var Shunt Compensators. The pollen of each flower in the proposed FPA Algorithm is considered to indicate the control variable in vector form

$$flower = [\, P_{G2}, \ldots, P_{Gj}, V_{G1}, V_{G2}, \ldots, V_{Gng}, T_1, T_2, \ldots, T_{nt}, Q_{C1}, Q_{C2}, \ldots, Q_{Cnc} \,] \quad (19)$$

Cost Function

The main factor considered here is cost function, which is under minimization, and the penalty factor considered which is indicating that VAr generation at generator bus, voltage level of load buses. The cost function is written as

Minimize

$$\Psi = J^{multi}(x,u) + \lambda_V \sum_{i \in \Re} \left(V_{Li} - V_{Li}^{\text{limit}}\right)^2 + \lambda_Q \sum_{i \in Z} \left(Q_{Gi} - Q_{Gi}^{\text{limit}}\right)^2 + \lambda_P \left(P_{Gs} - P_{Gs}^{\text{limit}}\right)^2 \quad (20)$$

Where

$$V_{Li}^{\text{limit}} = \begin{cases} V_{Li}^{\min} & \text{if } V_{Li} < V_{Li}^{\min} \\ V_{Li}^{\max} & \text{if } V_{Li} > V_{Li}^{\max} \end{cases} \quad (21)$$

$$Q_{Gi}^{\text{limit}} = \begin{cases} Q_{Gi}^{\min} & \text{if } Q_{Gi} < Q_{Gi}^{\min} \\ Q_{Gi}^{\max} & \text{if } Q_{Gi} > Q_{Gi}^{\max} \end{cases} \quad (22)$$

$$P_{Gs}^{\text{limit}} = \begin{cases} P_{Gs}^{\min} & \text{if } P_{Gs} < P_{Gs}^{\min} \\ P_{Gs}^{\max} & \text{if } P_{Gs} > P_{Gs}^{\max} \end{cases} \quad (23)$$

Stopping Rule

If the repeated results occurred in the global best solution, process is terminated. Suppose if the no of iteration if fixed then also, terminated if the last iteration is reached

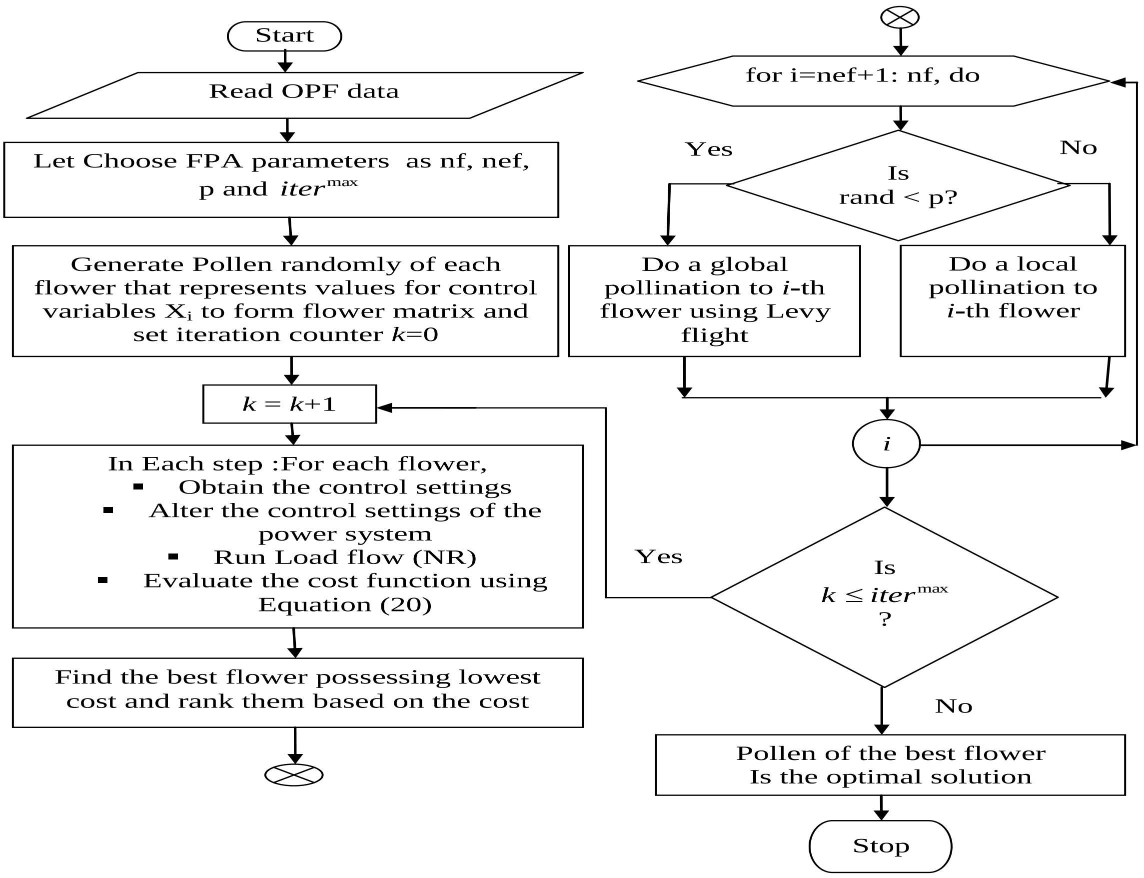

Fig. 1 Flow chart of PM

5. Test System and Results

The Proposed Method has been evaluated on IEEE 30 bus test system. The generator data shunt capacitor data, bus data and line data are given through Tables Appendix (A1 to A5). The power system located with tap setting transformer at between the buses 6 to 9, 6 to 10, 4 to 12 and 28 to 27. Generators totally six as in the bus no 1, 2,5,8,11,13. Variable VAR Compensators located at the bus no 10,12,15,17,20,21,23,24,29. Consider the base of 100MVA. The total load consider as 2.834 on the common base. The voltage limits were taken as 0.95 and 1.1 for the generator and load buses on the common rating. Newton Raphson Method is adopted to carry out the load flow during the Flower Pollination optimization process. The solution for the all the target and test system results displayed the table 1.

Table 1 Optimal Control Settings of PM

Control variable	Base case	Target 1	Target 2	Target 3
P_{G1}	99.216	177.001	51.473	127.49
P_{G2}	80	48.64	79.9673	51.5816
P_{G5}	50	21.239	49.9088	30.0284
P_{G8}	20	21.136	34.9865	34.9088
P_{G11}	20	11.955	29.9688	25.0419
P_{G13}	20	12.054	39.9623	19.7995
V_{G1}	1.056	1.1000	1.0975	1.1000
V_{G2}	1.04	1.0877	1.0928	1.0876
V_{G5}	1.01	1.0614	1.0751	1.0648
V_{G8}	1.01	1.0695	1.0814	1.0730
V_{G11}	1.05	1.0977	1.1000	1.0988
V_{G13}	1.05	1.0998	1.0994	1.0997
T_{6-9}	1.078	1.0360	0.9948	0.9845
T_{4-12}	1.032	0.999	0.9698	0.9642
T_{6-10}	1.069	0.9	0.94623	0.92677
T_{28-27}	1.068	0.9667	0.9688	0.9583
Q_{C10}	0.0	0.0555	0.0492	0.04988
Q_{C12}	0.0	0.0316	0.0405	0.0499
Q_{C15}	0.0	0.050	0.04994	0.0498
Q_{C17}	0.0	0.050	0.0498	0.0493
Q_{C20}	0.0	0.04355	0.0458	0.0478
Q_{C21}	0.0	0.05	0.0495	0.0486
Q_{C23}	0.0	0.03424	0.03664	0.0359

The solution is compared with all other solution search techniques like DE, ABC, AGA, improved GA, and BBO. The results was presented at table 2

Table 2 Comparison of results for all the test cases

	Algorithm	Fuel Cost	Loss
Base Case	--	901.935	5.013
	DE	799.089	8.615

Target 1	EGA	799.566	8.697
	BBO	799.1116	8.63
	Proposed FPA	**799.0566**	8.615
	AGA	799.8441	8.9155
	ABC	800.66	9.0328
Target 2	ABC	967.681	3.1078
	EGA	967.86	3.2008
	Proposed FPA	966.408	**2.867**
Target 3	Proposed FPA	**822.769**	**5.452**
	EGA	822.87	5.614

It is observed that from the table that the Proposed Method that is Flower Pollination Algorithm is able to reduce the Net Fuel Cost to the lowest value of **799.055** \$/h.

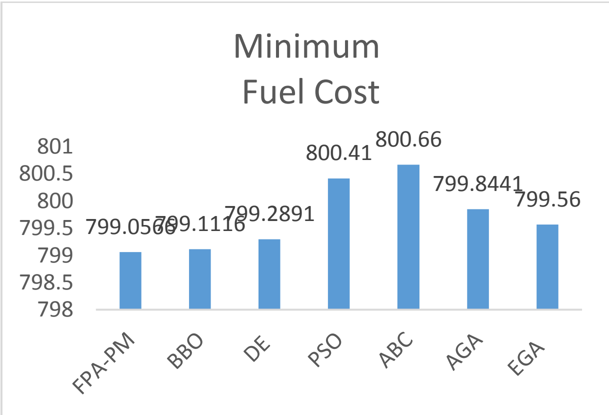

Fig 2. Chart result for minimum fuel cost

It is very clear from the table that the PM is able to reduce the NFC to the lowest value of 799.0566 \$/h

The convergence is happened quickly by compared with other methods. The convergence characteristics is shown in the fig 2, as observed that solution reached quickly by the proposed method Flower pollination algorithm

The solution taken for the more than 100 times and the test system and results are compared with existing solution methodologies. It is observed that average value off fuel cost proposed Flower pollination algorithm is close to the lower value. And also proposed method having lower value on time for convergence and efficiency

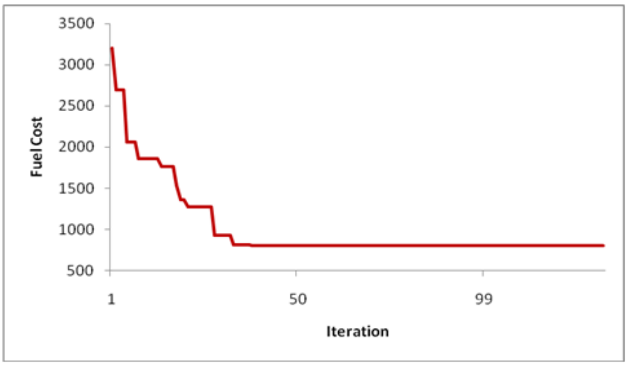

Fig 3 Convergence of Proposed FPA

In target 2 proposed Flower pollination algorithm reduces the total power loss as 2.867 MW and compared to the other methods obtained 3.2 MW and 3.108 MW respectively. It is observed that the real power loss reduction increases the total fuel cost rate as 966.408 $/h. It greater value compared to the base results.

In the Table 3 presented, the statistical result of the maximum and minimum fuel cost occurred compared with the other solution search methods. It is observed that the proposed method providing the acceptable solution.

Real power loss comparison chart

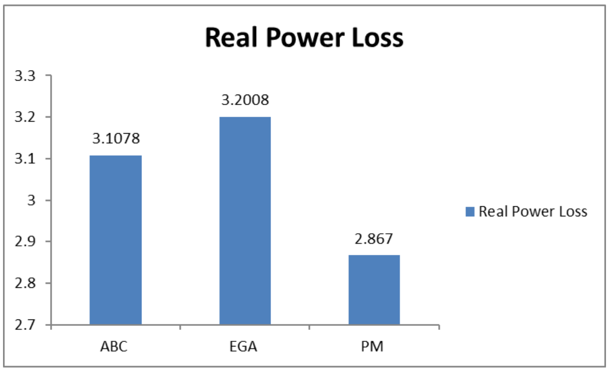

Fig 4 comparison chart of real power loss

From the above figure observed, that proposed method is obtaining the lower loss compared to the other methods

Statistical Comparison of Results for Total Fuel cost

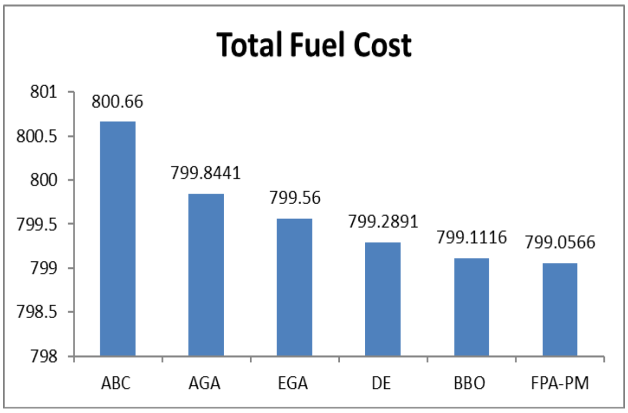

Fig 5 Comparison of result descending order

Table 3 Statistical comparison of results

Test system	Algorithm	Total Fuel Cost $/h			Success Rate (%)	NET (Secs)
		Avg	Max	Min		
30 bus	**PM-FPA**	799.092	799.130	799.056	97	107.1
	BBO	799.198	799.204	799.1116	---	110.2
	DE	---	--	799.2891	---	---
	PSO	---	--	800.41	---	---
	ABC	800.871	801.867	800.6600	---	---
	AGA	---	--	799.8441	---	---
	EGA	---	--	799.56	---	---

6. Summary

In this paper optimal power flow performed for 30 bus system. The effectiveness of the proposed Flower Pollination algorithm is investigated. It is proved that solution space reached at the less time rate and accuracy of results, because of the nature of solution algorithm under global best. The proposed Flower pollination algorithm called as an elegant solution method for searching optimality in power system.

7. References

[1] Abdel-Fattah Attia, Yusuf A.Al-Turki and Abdullah M.Abusorrah. (2012) "Optimal power flow using adapted genetic algorithm with adjusting population size", Electric Power Components and Systems, 40: 1285-99.

[2] Abou El Ela, A.A., Abido, M.A. (2010). "Optimal power flow using differential evolution algorithm", Electr. Power Syst. Res., 80 (7): 878–885

[3] Attia A. El-Fergany and Almoataz Y. Abdelaziz. (2014) "Artificial Bee Colony Algorithm to Allocate Fixedand Switched Static Shunt Capacitors in RadialDistribution Networks", Electric Power Components and Systems, 42(5):427–438.

[4] Camille Hamon, Magnus Perninge and Lennart Soder. (2013) "A Stochastic Optimal Power Flow Problem With Stability Constraints—Part I: Approximating the Stability Boundary", IEEE Trans. on Power Systems, 28(2): 1839-1848.

[5] Duman S, Güvenç U, Sönmez Y and Yörükeren N. (2012) " Optimal power flow using gravitational search algorithm". Energy Convers Manage, 59: 86-95

[6] Han Yu and W. D. Rosehart. (2012) " An Optimal Power Flow Algorithm to Achieve Robust Operation Considering Load and Renewable Robust Operation Considering Load and Renewable Generation Uncertainties", IEEE Trans. on Power Systems, 27(4):1808-1817.

[7] Mojtaba Ghasemi, Sahand Ghavidel, Mohsen Gitizadeh and Ebrahim Akbari. (2015) " An improvedteaching-learning-based optimization algorithm using Levy mutation strategy for non-smooth optimal power flow", Electrical Power and Energy Systems, 65: 375–384.

[8] Mohamed Shuaib Y, M. Surya Kalavathi, and C. Christober Asir Rajan. (2014) " Optimal Reconfiguration in Radial Distribution System Using Gravitational Search Algorithm", Electric Power Components and Systems, 42(7):703–715.

[9] Mahmood Joorabian and Ehsan Afzalan. (2014) " Optimal power flow under both normal and contingent operation conditions using the hybrid fuzzy particle swarm optimisation and Nelder–Mead algorithm", Applied Soft Computing, 14: 623–633.

[10] Mojtaba Khanabadi, Hassan Ghasemi and Meysam Doostizadeh. (2013) "Optimal Transmission Switching Considering Voltage Security and N-1 Contingency Analysis", IEEE Trans. on Power Systems, 28(1):542-550.

[11] Rezaei Adaryani M and A. Karami. (2013) "Artificial bee colony algorithm for solving multi-objective optimal power flow problem", Electrical Power and Energy Systems, 53 : 219–230.

[12] Sailaja Kumari M and Maheswarapu S. (2010). "Enhanced genetic algorithm based computation technique for multi-objective optimal power flow". Electrical Power & Energy Syst., 32(6): 736-42.

[13] Srinivasa Rao B, K. Vaisakh. (2013). "Multi-objective adaptive Clonal selection algorithm for solving environmental/economic dispatch and OPF problems with load uncertainty", Electrical Power and Energy Systems, 53:390–408.

[14] X.S. Yang, M. Karamanoglu, and X. He. (2013). "Multi-objective Flower Algorithm for Optimization, Procedia Computer Science", 18: 61-68

[15] X.S. Yang. (2012). "Flower Pollination Algorithm for Global Optimization, Unconventional Computation and Natural Computation", Lecture Notes in Computer Science, 7445: 240-249.

APPENDIX A

Table A1 Cost Characteristics data for IEEE 30 bus test system

Bus	a	b	c	d	e	$P_j^{G(\min)}$	$P_j^{G(\max)}$	$Q_j^{G(\min)}$	$Q_j^{G(\max)}$

1	0.00375	2.00	0	0	0	50	200	-20	250
2	0.01750	1.75	0	0	0	20	80	-20	100
5	0.06250	1.00	0	0	0	15	50	-15	80
8	0.00834	3.25	0	0	0	10	35	-15	60
11	0.02500	3.00	0	0	0	10	30	-10	50
13	0.02500	3.00	0	0	0	12	40	-15	60

Table A2 Shunt Capacitor Data

Bus	$Q^{C(\min)}$	$Q^{C(\max)}$
10	0	5
12	0	5
15	0	5
17	0	5
20	0	5
21	0	5
23	0	5
24	0	5
29	0	5

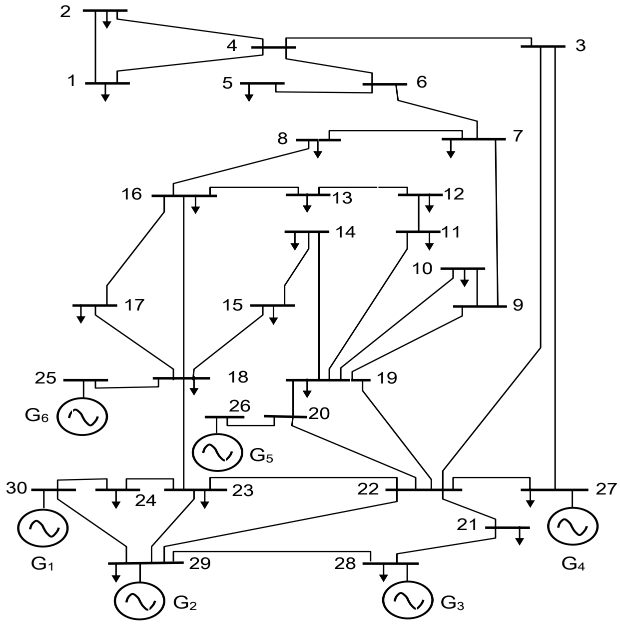

Fig.A1 Single Line Diagram of IEEE 30-bus test system

Table A3 Bus data of the Test System IEEE 30 bus system

Bus No	VM (per unit)	P_L (MW)	Q_L (MVAR)	P_G (MW)
1	1.05	---	---	---
2	1.04	21.70	12.7	80.0
3	---	2.4	1.2	---
4	---	7.6	1.6	---
5	1.01	94.2	19.0	50.0
6	---	0.0	0.0	---
7	---	22.8	10.9	---
8	1.01	30.0	30.0	20.0
9	---	0.0	0.0	---
10	---	5.8	2.0	---
11	1.05	0.0	0.0	20.0
12	---	11.2	7.5	---
13	1.05	0.0	0.0	20.0
14	---	6.2	1.6	---
15	---	8.2	2.5	---
16	---	3.5	1.8	---
17	---	9.0	5.8	---
18	---	3.2	0.9	---
19	---	9.5	3.4	---

20	---	2.2	0.7	---
21	---	17.5	11.2	---
22	---	0.0	0.0	---
23	---	3.2	1.6	---
24	---	8.7	6.7	---
25	---	0.0	0.0	---
26	---	3.5	2.3	---
27	---	0.0	0.0	---
28	---	0.0	0.0	---
29	---	2.4	0.9	---
30	---	10.6	1.9	---

Table A4 Line data of the IEEE 30 bus system

Between Buses	R_L	X_L	$B_C^{1/2}$	TTS
1-2	0.0192	0.0575	0.02640	---
1-3	0.0452	0.1852	0.02040	---
2-4	0.0570	0.1737	0.01840	---
3-4	0.0132	0.0379	0.00420	---
2-5	0.0472	0.1983	0.02090	---
2-6	0.0581	0.1763	0.01870	---
4-6	0.0119	0.0414	0.00450	---
5-7	0.0460	0.1160	0.01020	---
6-7	0.0267	0.0820	0.00850	---
6-8	0.0120	0.0420	0.00450	---
6-9	0	0.2080	0	1.078
6-10	0	0.5560	0	1.069
9-11	0	0.2080	0	---
9-10	0	0.1100	0	---
4-12	0	0.2560	0	1.032
12-13	0	0.1400	0	---
12-14	0.1231	0.2559	0	---
12-15	0.0662	0.1304	0	---
12-16	0.0945	0.1987	0	---
14-15	0.2210	0.1997	0	---
16-17	0.0824	0.1923	0	---

Table A4 (Continued)

Between Buses	R_L	X_L	$B_C^{1/2}$	TTS
15-18	0.1073	0.2185	0	---
18-19	0.0639	0.1292	0	---
19-20	0.0340	0.0680	0	---
10-20	0.0936	0.2090	0	---
10-17	0.0324	0.0845	0	---
10-21	0.0348	0.0749	0	---
10-22	0.0727	0.1499	0	---
21-22	0.0116	0.0236	0	---
15-23	0.1000	0.2020	0	---
22-24	0.1150	0.1790	0	---
23-24	0.1320	0.2700	0	---
24-25	0.1885	0.3292	0	---
25-26	0.2544	0.3800	0	---
25-27	0.1093	0.2087	0	---
28-27	0	0.3960	0	1.068
27-29	0.2198	0.4153	0	---
27-30	0.3202	0.6027	0	---
29-30	0.2399	0.4533	0	---
8-28	0.0636	0.2000	0.0214	---
6-28	0.0169	0.0599	0.065	---