

CONGESTION MANAGEMENT IN NINE BUS SYSTEM USING THYRISTOR CONTROLLED SERIES CAPACITOR\

S.Arthisuriya¹, S.Sherine²

Assistant Professor^{1,2}, Department of Electrical and Electronics Engineering^{1,2}

BIST, BIHER, Bharath University, Chennai

arthisuriya.eee@bharathuniv.ac.in

Abstract: Congestion management is one of the important parameters to be monitored in a multibus system. This work deals with modelling and simulation of nine bus system employing thyristor controlled series capacitors (TCSC). Nine bus system with and without TCSC are modelled and simulated using MATLAB simulink software and the results are presented. This paper presents the best location of TCSC to reduce congestion.

1. Introduction

The need of electrical vitality is expanding step by step because of the development of ventures and their expanded request. To deal with the extended load request, the power division for the most part is stretched out by modifying. The power sector has been regularized to increase the electrical energy to meet the industrial load demands. Deregulation of power division led to the involvement of private participants in the power sector industry[1-9]. As the participation of private sector increased their generating capacity, the transmission line has to supply all the transactions by these private entities. This resulted in massive utilization of transmission system.

The transmission line must be worked near its physical and warm breaking points. Due to the increased demand, there have been some undesired transactions that is violating the operating limits of transmission system which results in transmission congestion. Overseeing clog and keeping up the transmission line with in the physical and

warm breaking points is extremely troublesome in some situation.

The Independent System Operator has to relieve and manage congestion congestion as soon as possible to maintain the stability of the transmission system. Various systems have been adjusted in overseeing the constrain for the most of the part called as blockage administration. The congestion in transmission lines is overloading the transmission line which can be relieved by cost-free and non-cost free means. The cost-free means includes the re-modelling of structure of power system, by varying the tapings of transformers and by FACTS devices. Another approach of congestion management is rescheduling of generators [9-10] and curtailing the loads.

1.1 Literature Survey

Various congestion management methods are followed in the deregulated power system to alleviate congestion management[42-45]. The Independent system operator (ISO) alleviates congestion in transmission line by varying various control parameters of the power system. Another method of managing congestion is by rescheduling of the participating generators. Congestion alleviation by managing transactional agreements between seller and buyer is also widely followed.

Rescheduling of participating hydro and thermal generating stations using the control parameters of generators and based on the availability of water resources has

been implemented to relieve congestion in [2].

Congestion management by optimal placement of Distributed generators (DG) based on the sensitivity of critical lines have been addressed in [3].

The active powers of the participating generators are rescheduled to relieve congestion by sensitivity of the generators to the congested line and congestion cost is reduced by different evolutionary algorithms [1,4].

The Transient stability margin corresponding to the generation and demand is varied to manage congestion in deregulated power system [7-12].

Flexible alternating current transmission system (FACTS) is another best alternative power electronics technology that can be adopted for

transmission system in enhancing the available Transfer limit and managing congestion [6].

FACTS devices are placed optimally in the transmission network for relieving congestion. Identifying the Correct location of FACTS devices by using various techniques to relieve congestion is proposed in [7, 8, 9, 10].

In this paper placement of TCSC in nine bus system has been proposed to improve the load-ability limit of transmission line. The real power flow transfer is improved by using two TCSC circuit model by improved bus voltage[13-18].

The above literature does not deal with reduction of congestion in nine bus system using multiple TCSC. This work proposes TCSC to reduce congestion[27-34].

1.2 Modelling of TCSC

Certainities gadgets are ended up being a creation for development of execution of transmission framework. Actualities gadgets are utilized to enhance the heap capacity breaking point of transmission line,

expanding as far as possible and all the more genuine power exchange. One such FACTS device employed for improving performance of transmission system is TCSC[35-41].

A Fixed power injection model (PIM) of TCSC is shown in figure 1 and it is used for congestion management. The power injection model explains the real and reactive power injection by the facts devices[19-26].

A Simple representation of transmission line with bus-a and bus-b is shown in figure 2.

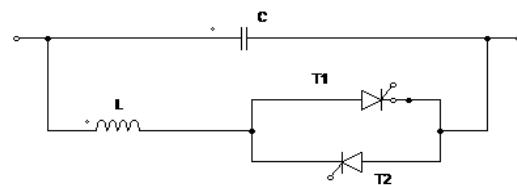


Figure 1
Circuit of TCSC

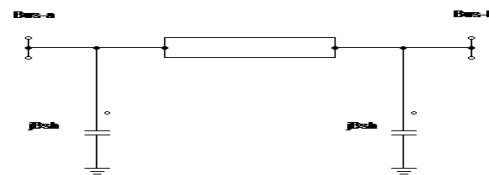


Figure 2

A Simple representation of transmission line
The real and reactive power flow from bus-a to bus-b is given by

$$P_{ab} = V_a^2 G_{ab} - V_a V_b [G_{ab} \cos(\delta_{ab}) + B_{ab} \sin(\delta_{ab})] \quad (1)$$

Error! Reference source not found.]

(2)

The real and reactive power flow from bus-b to bus-a is given by

$$P_{ab} = V_b^2 G_{ab} - V_a V_b [G_{ab} \cos(\delta_{ab}) + B_{ab} \sin(\delta_{ab})] \quad (3)$$

Error! Reference source not found.](4)

Where,

Error! Reference source not found.=Error! Reference source not found. (5)

Error! Reference source not found.
Error! Reference source not found.
(6)

2 Simulation Model of 9 Bus System Without TCSC For Linear and non linear Load:

The simulink model of 9- bus system with linear and nonlinear loads is shown in figure 2.1 9- bus system without TCSC & with linear loads

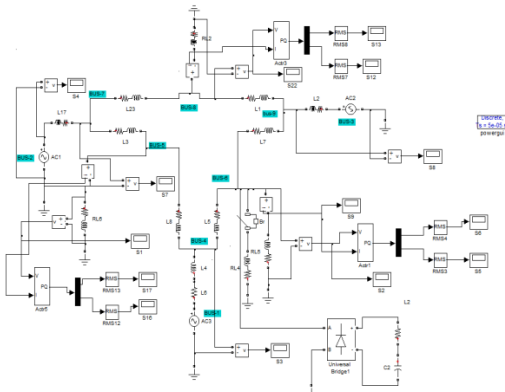


Figure 2.1

Nine bus system without TCSC & with linear loads is shown in Fig 2.1. The Real power and Reactive power are shown in Fig 2.2 and its value real value is 2.8×10^7 W, reactive power value is 1.8×10^7 VAR.

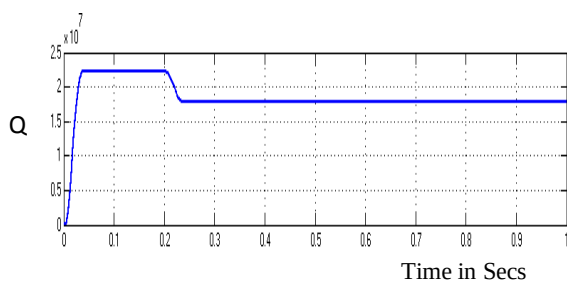
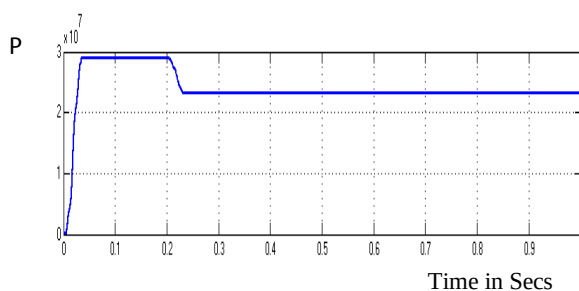


Figure 2.2 Real and Reactive Power at bus -6

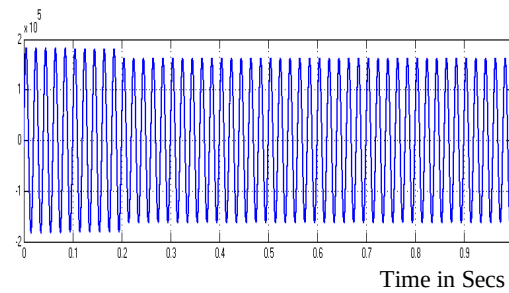


Figure 2.3. Voltage bus-6

The voltage at bus 6 is shown in Fig 2.3 and its peak value is 1.8×10^5 V. The voltage at bus 8 is shown in Fig 2.4 and its value is 2×10^5 V. The real power and reactive power at bus 8 are shown in Fig 2.5. The value of real power is 3.4×10^7 W and reactive power value is 11×10^6 VAR. The frequency spectrum is shown in Fig 2.6

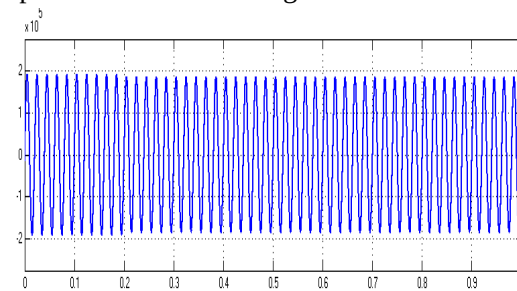


Fig 2.4 Voltage at bus-8

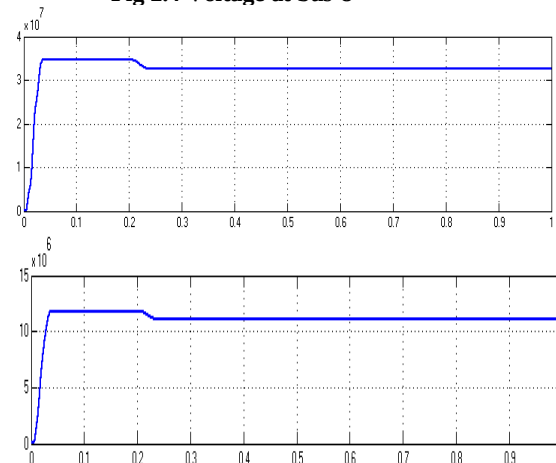


Figure 2.5 Real and Reactive Power at bus -8

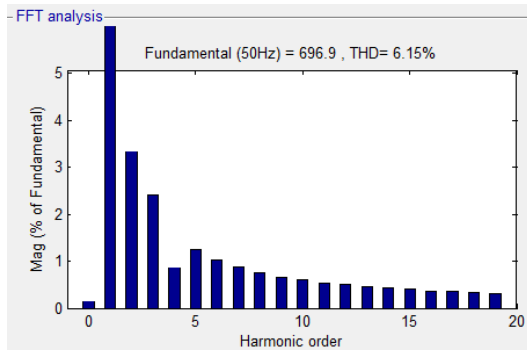


Figure 2.6 Frequency Spectrum

3 Simulation Model of 9- Bus System with TCSC for Linear and non linear Loads:

Nine bus system with TCSC is shown

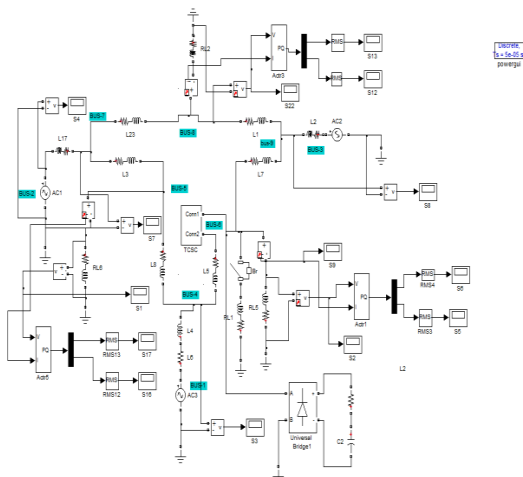


Figure 3.1 9- bus system with TCSC

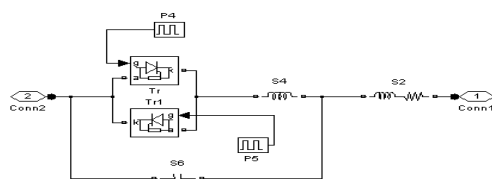


Figure 3.2 TCSC Circuit

in Fig 3.1. The TCSC Circuit is shown in Fig 3.2. The Real power and Reactive power at bus six are shown in Fig 3.3 and real value is 3.9×10^7 V, reactive power value is 2.9×10^7 V. The voltage bus 6 is shown in Fig 3.4 and its peak value is 1.6×10^5 V. The real power and reactive power at bus 8 are shown in Fig 3.5 and its value real power 3.4×10^7 V, reactive power value is 11×10^6 V. The voltage at bus 8 is shown in Fig 3.6 and its value is 2×10^5 V. The frequency spectrum for output current is shown in Fig 3.7. The summary real and reactive power with and without TCSC are given in Table 1. The real and reactive powers increase with the addition of TCSC.

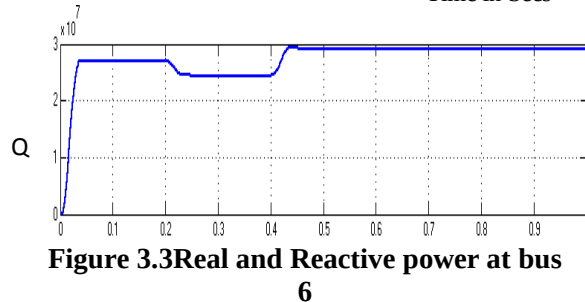
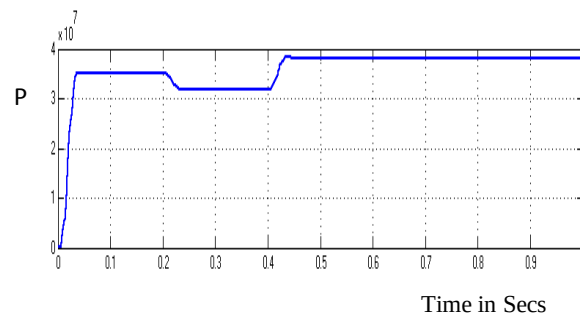
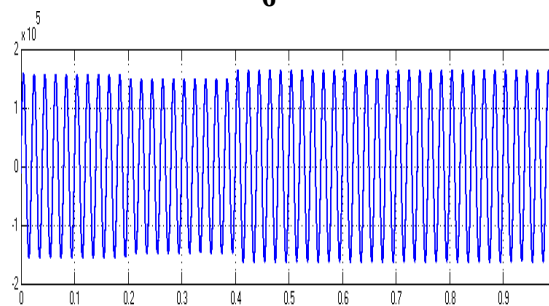


Figure 3.3 Real and Reactive power at bus 6

Figure 3.4 Voltage at bus-8
Time in Secs

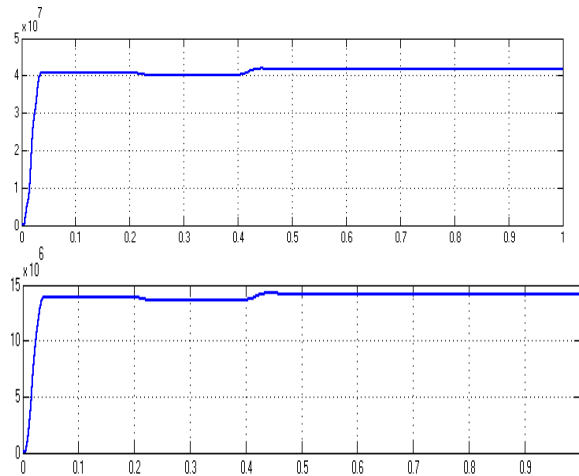


Figure 3.5 Real and Reactive power at bus 8

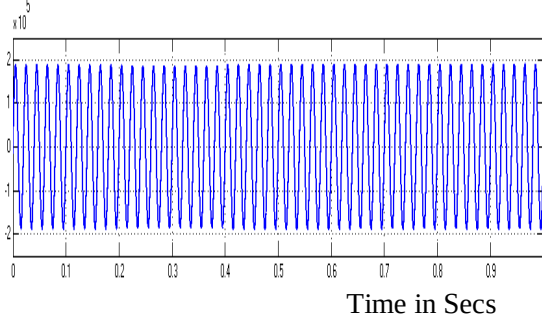


Figure 3.6 Voltage at bus 8

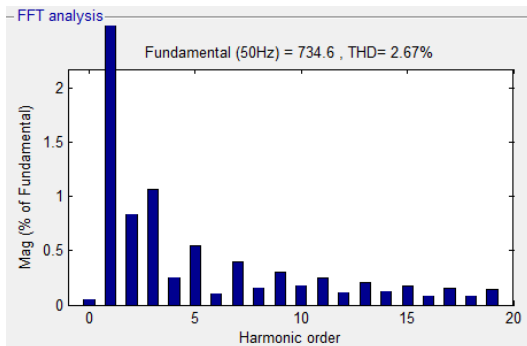


Fig 3.7 Freq spectrum for O/P current Table 1

Summary of Real and Reactive powers

9-bus	Real power (MW) Without TCSC	Real power (MW) With TCSC	Reactive power (MVAR) Without TCSC	Reactive power (MVAR) With TCSC
Bus-5	41.19	43.31	16.13	18.32
Bus-6	25.45	38.05	17.25	28.60
Bus-8	33.35	42.21	12.43	16.68

Table –2 Summary of bus voltages with and without TCSC

9-bus	Voltage without TCSC	Voltage with TCSC
Bus-5	187kv	188kv
Bus-6	162kv	175kv
Bus-8	191kv	200kv

Conclusion:

The nine bus system has been simulated and run with and without TCSC for both linear and non linear loads to observe its performance. It is clear that the real power transmitted with TCSC is higher than without TCSC. The real power flow with single TCSC increases due to the improved bus voltage. The improvement of real power flow in the nine bus system is also much better with the introduction of with TCSC devices.

The FACTS device TCSC is implemented as it is cheaper than other FACTS devices such as UPFC and IPFC. It is observed that TCSC is more suitable to reduce transmission congestion and to control the power through the transmission lines. The disadvantage of TCSC is that it introduces current harmonics into the transmission line.

The extent of the present work is to reduce the congestion in nine bus system. The congestion management in fourteen bus system will be done in future.

References :

1. Nimal, R.J.G.R., Hussain, J.H., Effect of deep cryogenic treatment on EN24 steel, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-113-116, 2017
2. Parameswari, D., Khanaa, V., Deploying lampport clocks and linked lists, International Journal of Pharmacy and Technology, V-8, I-3, PP-17039-17044, 2016

3. Parameswari, D., Khanaa, V., Case for massive multiplayer online role-playing games, *International Journal of Pharmacy and Technology*, V-8, I-3, PP-17404-17409, 2016
4. Parameswari, D., Khanaa, V., Deconstructing model checking with hueddot, *International Journal of Pharmacy and Technology*, V-8, I-3, PP-17370-17375, 2016
5. Parameswari, D., Khanaa, V., The effect of self-learning epistemologies on theory, *International Journal of Pharmacy and Technology*, V-8, I-3, PP-17314-17320, 2016
6. Pavithra, J., Peter, M., GowthamAashirwad, K., A study on business process in IT and systems through extranet, *International Journal of Pure and Applied Mathematics*, V-116, I-19 Special Issue, PP-571-576, 2017
7. Pavithra, J., Ramamoorthy, R., Satyapira Das, S., A report on evaluating the effectiveness of working capital management in googolsoft technologies, Chennai, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-129-132, 2017
8. Pavithra, J., Thooyamani, K.P., A cram on consumer behaviour on Mahindra two wheelers in Chennai, *International Journal of Pure and Applied Mathematics*, V-116, I-18 Special Issue, PP-55-57, 2017
9. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the air freight customer satisfaction, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-179-184, 2017
10. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the working capital management of TVS credit services limited, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-185-187, 2017
11. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the analysis of financial performance with reference to Jeppiaar Cements Pvt Ltd, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-189-194, 2017
12. Peter, M., Dayakar, P., Gupta, C., A study on employee motivation at Banalari World Cars Pvt Ltd Shillong, *International Journal of Pure and Applied Mathematics*, V-116, I-18 Special Issue, PP-291-294, 2017
13. Peter, M., Kausalya, R., A study on capital budgeting with reference to signware technologies, *International Journal of Pure and Applied Mathematics*, V-116, I-18 Special Issue, PP-71-74, 2017
14. Peter, M., Kausalya, R., Akash, R., A study on career development with reference to premheerasurgicals, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-415-420, 2017
15. Peter, M., Kausalya, R., Mohanta, S., A study on awareness about the cost reduction and elimination of waste among employees in life line multispeciality hospital, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-287-293, 2017
16. Peter, M., Srinivasan, V., Vignesh, A., A study on working capital management at deccan Finance Pvt Limited Chennai, *International Journal of Pure and Applied Mathematics*, V-116, I-14 Special Issue, PP-255-260, 2017
17. Peter, M., Thooyamani, K.P., Srinivasan, V., A study on performance of the commodity market based on technicalanalysis, *International Journal of Pure and Applied Mathematics*, V-116, I-18 Special Issue, PP-99-103, 2017
18. Philomina, S., Karthik, B., Wi-Fi energy meter implementation using embedded linux in ARM 9, *Middle - East Journal of Scientific Research*, V-20, I-12, PP-2434-2438, 2014
19. Philomina, S., Subbulakshmi, K., Efficient wireless message transfer

- system, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-289-293, 2017
20. Philomina, S., Subbulakshmi, K., Ignition system for vehicles on the basis of GSM, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-283-286, 2017
 21. Philomina, S., Subbulakshmi, K., Avoidance of fire accident by wireless sensor network, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-295-299, 2017
 22. Pothumani, S., Anuradha, C., Monitoring android mobiles in an industry, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-537-540, 2017
 23. Pothumani, S., Anuradha, C., Decoy method on various environments - A survey, International Journal of Pure and Applied Mathematics, V-116, I-10 Special Issue, PP-197-199, 2017
 24. Pothumani, S., Anuradha, C., Priya, N., Study on apple iCloud, International Journal of Pure and Applied Mathematics, V-116, I-8 Special Issue, PP-389-391, 2017
 25. Pothumani, S., Hameed Hussain, J., A novel economic framework for cloud and grid computing, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-5-8, 2017
 26. Pothumani, S., Hameed Hussain, J., A novel method to manage network requirements, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-9-15, 2017
 27. Pradeep, R., Vikram, C.J., Naveenchandran, P., Experimental evaluation and finite element analysis of composite leaf spring for automotive vehicle, Middle - East Journal of Scientific Research, V-17, I-12, PP-1760-1763, 2013
 28. Prakash, S., Jayalakshmi, V., Power quality improvement using matrix converter, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-95-98, 2017
 29. Prakash, S., Jayalakshmi, V., Power quality analysis & power system study in high voltage systems, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-47-52, 2017
 30. Prakash, S., Sherine, S., Control of BLDC motor powered electric vehicle using indirect vector control and sliding mode observer, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-295-299, 2017
 31. Prakesh, S., Sherine, S., Forecasting methodologies of solar resource and PV power for smart grid energy management, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-313-317, 2017
 32. Prasanna, D., Arulselvi, S., Decoupling smalltalk from rpcs in access points, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-1-4, 2017
 33. Prasanna, D., Arulselvi, S., Exploring gigabit switches and journaling file systems, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-13-17, 2017
 34. Prasanna, D., Arulselvi, S., Collaborative configurations for wireless sensor networks systems, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-577-581, 2017
 35. Priya, N., Anuradha, C., Kavitha, R., Li-Fi science transmission of knowledge by way of light, International Journal of Pure and Applied Mathematics, V-116, I-9 Special Issue, PP-285-290, 2017
 36. Priya, N., Pothumani, S., Kavitha, R., Merging of e-commerce and e-market-a novel approach, International Journal of Pure and Applied Mathematics, V-116, I-9 Special Issue, PP-313-316, 2017

37. Raj, R.M., Karthik, B., Effective demining based on statistical modeling for detecting thermal infrared, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-273-276, 2017
38. Raj, R.M., Karthik, B., Energy sag mitigation for chopper, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-267-270, 2017
39. Raj, R.M., Karthik, B., Efficient survey in CDMA system on the basis of error revealing, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-279-281, 2017
40. Rajasulochana, P., Krishnamoorthy, P., Ramesh Babu, P., Datta, R., Innovative business modeling towards sustainable E-Health applications, International Journal of Pharmacy and Technology, V-4, I-4, PP-4898-4904, 2012
41. Rama, A., Nalini, C., Shanthi, E., An iris based authentication system by eye localization, International Journal of Pharmacy and Technology, V-8, I-4, PP-23973-23980, 2016
42. Rama, A., Nalini, C., Shanthi, E., Effective collaborative target tracking in wireless sensor networks, International Journal of Pharmacy and Technology, V-8, I-4, PP-23981-23986, 2016
43. Pradeep, R., Vikram, C.J., Naveenchandra, P., Experimental evaluation and finite element analysis of composite leaf spring for automotive vehicle, Middle - East Journal of Scientific Research, V-12, I-12, PP-1750-1753, 2012
44. Ramamoorthy, R., Kanagasabai, V., Irshad Khan, S., Budget and budgetary control, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-189-191, 2017
45. Ramamoorthy, R., Kanagasabai, V., Jivandan, S., A study on training and development process at Vantec Logistics India Pvt Ltd, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-201-207, 2017

