Non-functional testing focuses on assessing the quality attributes of a software system that do not relate to its functionality, such as

- Performance

- Reliability

- Scalability

- Usability

- Maintainability

- security

The main goals of non-functional testing are to improve the usability, efficiency, maintainability, and portability of the product, minimize production risk and cost, optimize installation, setup, execution, management, and monitoring of the product, and collect measurements and metrics for internal research and development. It also aims to enhance the knowledge of the product behavior and technologies in use.
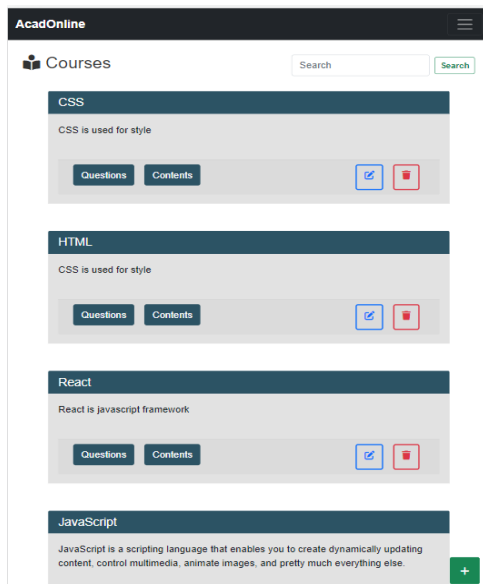
Non-functional Testing types:

- Performance testing

- Load testing

- Stress testing

- Volume testing

- Security testing

- Upgrade & installation testing

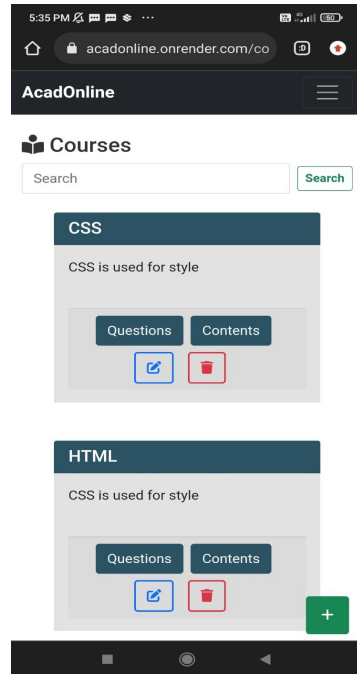- Recovery testing

1. Responsiveness

- Browser Interface
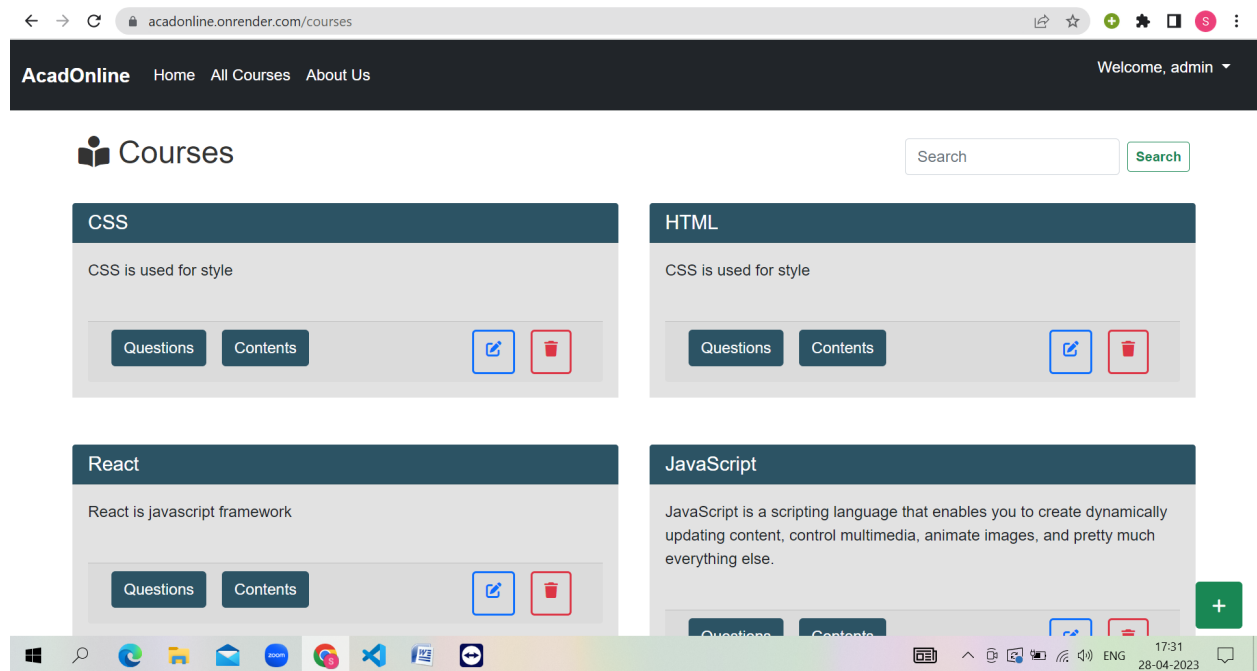
- Tablet Interface:

- Mobile interface:

As we see from above screenshots that system is responsive for different devices like browser, tablets and mobile devices. So, responsiveness is maintained.

2.   Correctness:
   ● Ratings should be submitted only once per user, if they want to resubmit the ratings, older one is deleted and current ratings always got updated with the average of all ratings entered uptill now correctly.
   ● Also, in QnA section and course content section the user who had added the question or reply can only had functionality to edit or delete that question/ reply or content. No other user had access to modify it. Other users cannot have any access to this.
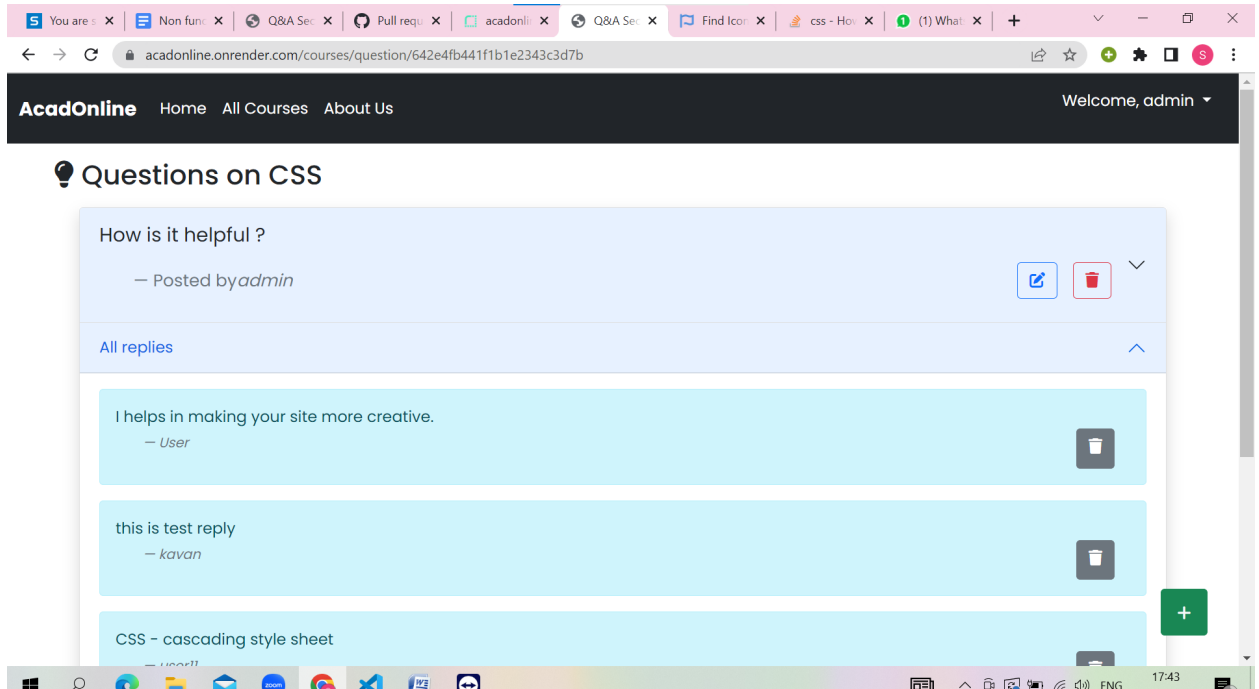
→ For QnA sections, here question is posted by admin so admin only had rights to edit and delete that question, while all other different users had given reply to that question so admin did not have right to delete that reply.

3. **Security**
   - The system works on session based login and authentication. If url is not correct then 404 Error page gets opened.
   - If user is not logged in then, page directly redirects to login page.
   - The password in mongoDb is stored in hash format using bcrypt , so password is not visible to anyone and hence it is secured.

4. **Ease of Use:**
   - The UI/UX is simple and attractive to understand and use. Any level of user can use this website with ease of use.
   - The frontend is simple and all error messages, alerts and warning are proper to understand. The system gives feedback at each and every point so that user doesn't get lost on the website.

5. Load testing :

Here we have performed the load testing **in Jmeter**.

A **Jmeter** Test Plan must have listener to showcase the result of performance test execution.

- Listeners capture the response coming back from Server while Jmeter runs and showcase in the form of – tree, tables, graphs and log files.

- It also allows you to save the result in a file for future reference. There are many types of listeners Jmeter provides. Some of them are: Summary Report, Aggregate Report, Aggregate Graph, View Results Tree, View Results in Table etc.

Here is the detailed understanding of each parameter in Summary report.

Label: It is the name/URL for the specific HTTP(s) Request. If you have selected "Include group name in label?" option then the name of the Thread Group is applied as the prefix to each label.

Samples: This indicates the number of virtual users per request.

Average: It is the average time taken by all the samples to execute specific label. In our case, the average time for Label 1 is 942 milliseconds & total average time is 584 milliseconds.

Min: The shortest time taken by a sample for specific label. If we look at Min value for Label 1 then, out of 20 samples shortest response time one of the sample had was 584 milliseconds.

Max: The longest time taken by a sample for specific label. If we look at Max value for Label 1 then, out of 20 samples longest response time one of the sample had was 2867 milliseconds.

Std. Dev.: This shows the set of exceptional cases which were deviating from the average value of sample response time. The lesser this value more consistent the data. Standard deviation should be less than or equal to half of the average time for a label.

Error%: Percentage of Failed requests per Label.

Throughput: Throughput is the number of request that are processed per time unit(seconds, minutes, hours) by the server. This time is calculated from the start of first sample to the end of the last sample. Larger throughput is better.

KB/Sec: This indicates the amount of data downloaded from server during the performance test execution. In short, it is the Throughput measured in Kilobytes per second.

First we have chosen **the number of users 700** and then we are changing the ramp-up time.

Here are some test-results for different ramp-up periods.

ramp-up time : 50s

Summary report :

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB...	Sent KB/sec	Avg. Bytes
home	700	8518	1054	16984	3524.99	0.00%	12.2/sec	98.81	1.42	8265.7
about us	700	5810	282	16183	1844.30	0.00%	11.4/sec	115.32	1.42	10334.6
contact-us	700	5973	286	15529	1764.21	0.00%	10.7/sec	122.70	1.34	11775.7
terms-of-use	700	5592	401	13596	1623.74	0.00%	10.3/sec	102.22	1.32	10210.6
privacy-policy	700	5158	645	13281	1724.94	0.00%	9.8/sec	91.58	1.28	9559.6
login	700	4438	658	13029	1755.17	0.00%	9.8/sec	87.39	1.20	9124.4
register	700	3782	291	13167	1863.86	0.00%	9.8/sec	129.85	1.23	13557.8
TOTAL	4900	5610	282	16984	2525.69	0.00%	65.3/sec	663.15	8.14	10404.1

Response time graph :
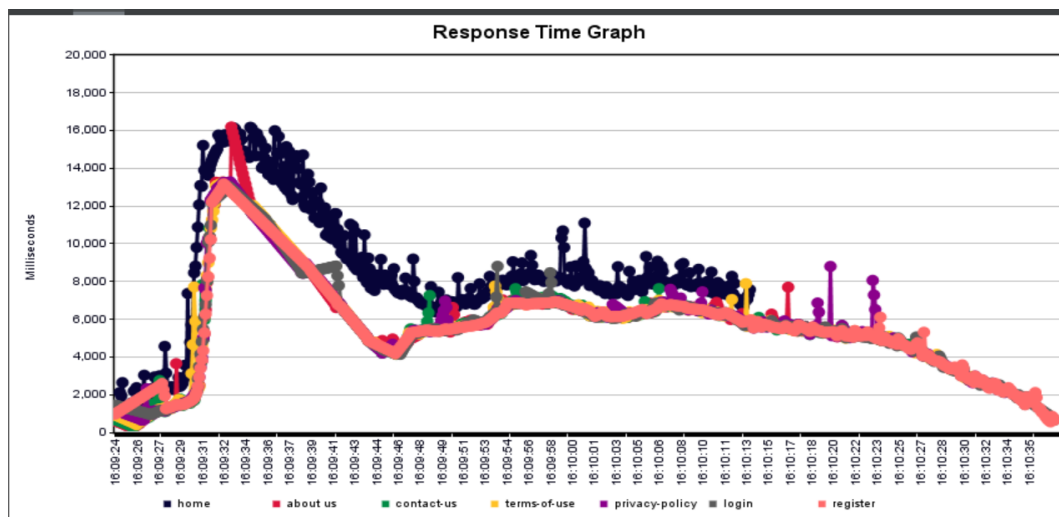
Ramp-up time : 25 seconds

Summary Report

Name: Summary Report

Comments:

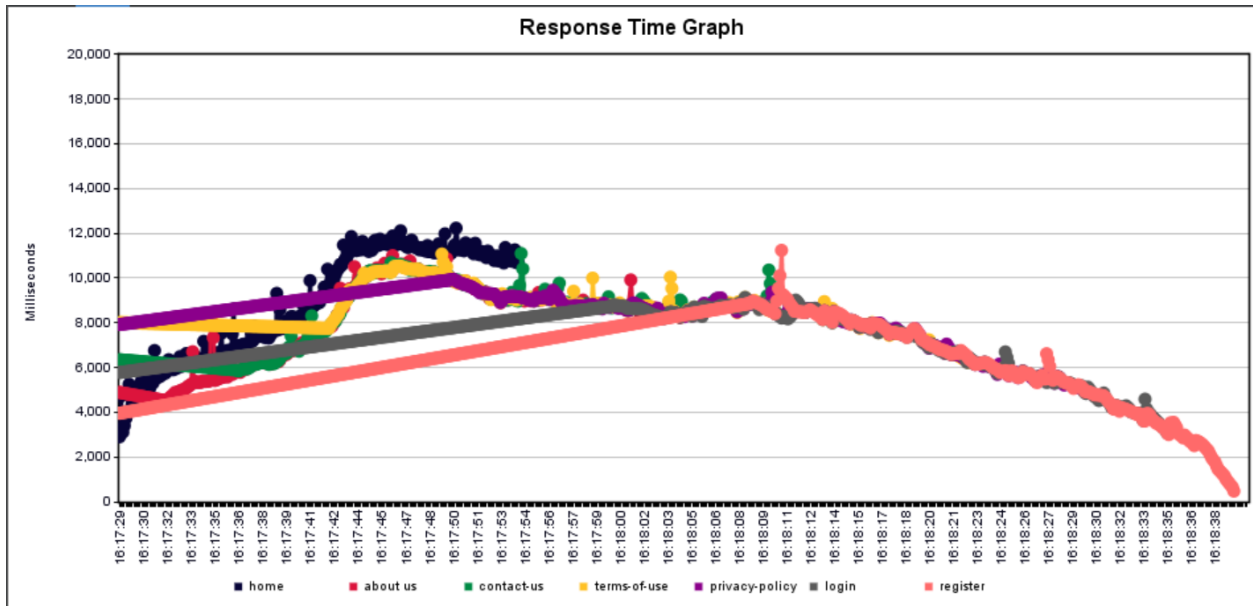Write results to file / Read from file
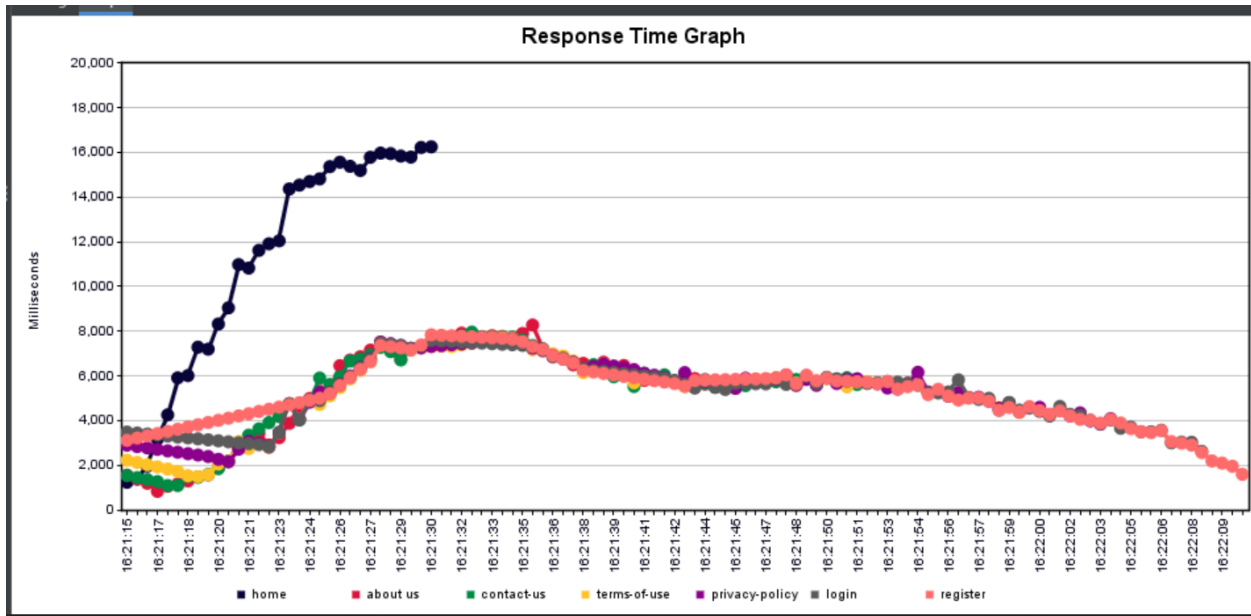
Filename [ ] Browse... Log/Display Only: ☐ Errors ☐ Successes [Configure]

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB...	Sent KB/sec	Avg. Bytes
home	700	8916	2836	14237	2447.59	0.00%	19.2/sec	154.99	2.23	8265.6
about us	700	8453	4502	12787	1475.32	0.00%	16.6/sec	167.73	2.06	10334.6
contact-us	700	8856	5848	12104	873.25	0.00%	15.2/sec	174.54	1.91	11775.6
terms-of-use	700	8380	6233	11990	931.93	0.00%	14.6/sec	145.55	1.88	10210.7
privacy-policy	700	7293	4826	12116	1333.46	0.00%	15.4/sec	144.09	2.02	9559.7
login	700	6104	3065	9128	1613.86	0.00%	17.4/sec	155.24	2.13	9124.7
register	700	4686	331	11237	1750.53	0.00%	21.8/sec	288.50	2.72	13557.6
TOTAL	4900	7527	331	14237	2160.65	0.00%	68.2/sec	693.42	8.51	10404.1

response time graph :

Ramp-up time : 15s

Summary Report

Name:	Summary Report									
Comments:										

Write results to file / Read from file

Filename: [Browse...] Log/Display Only: ☐ Errors ☐ Successes [Configure]

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB...	Sent KB/sec	Avg. Bytes
home	700	11354	1204	18684	4770.82	0.00%	21.4/sec	172.77	2.49	8265.5
about us	700	5705	627	10219	1824.10	0.00%	18.9/sec	190.75	2.34	10334.6
contact-us	700	5718	1060	12138	1449.08	0.00%	16.7/sec	191.71	2.10	11775.6
terms-of-use	700	5488	1396	8500	1107.51	0.00%	15.5/sec	154.28	1.99	10210.6
privacy-policy	700	5139	2125	9746	960.33	0.00%	14.5/sec	135.69	1.90	9559.7
login	700	4649	2618	9745	1049.02	0.00%	14.4/sec	128.38	1.76	9124.6
register	700	3893	836	12320	1440.09	0.00%	14.7/sec	195.27	1.84	13557.5
TOTAL	4900	5992	627	18684	3153.56	0.00%	86.0/sec	873.30	10.72	10404.0

response time graph :

Ramp-up time : 10s

response time graph :
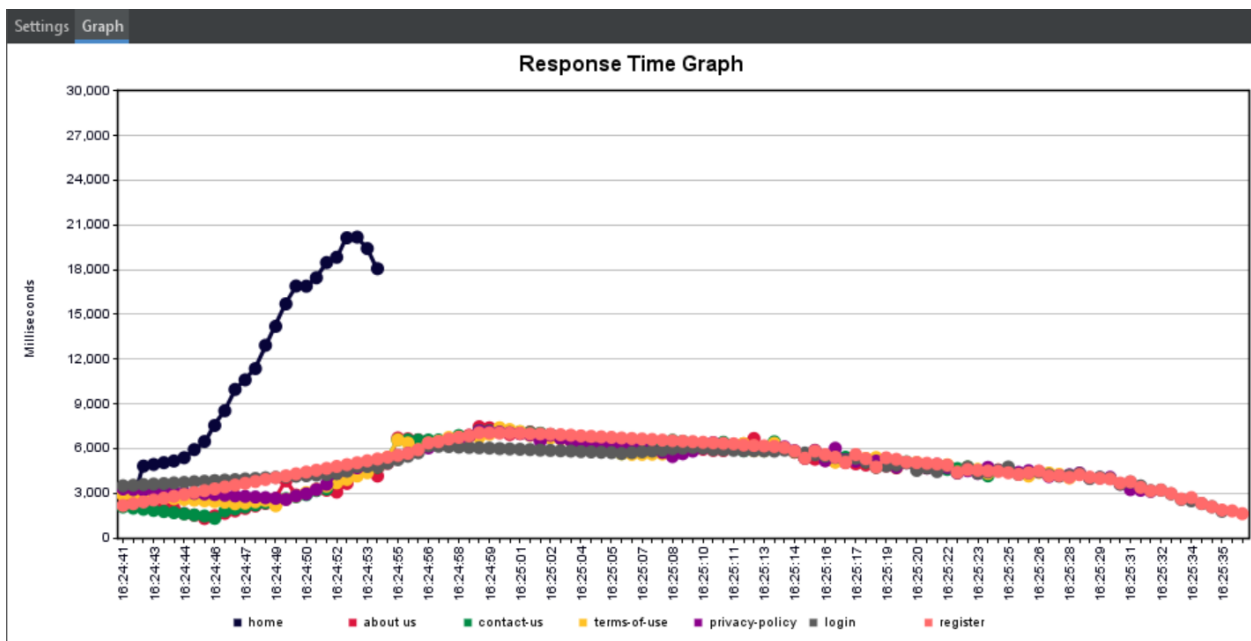
Ramp-up time : 5s

Summary Report

Name:	Summary Report									
Comments:										

Write results to file / Read from file

Filename: [   ] [Browse...] Log/Display Only: ☐ Errors ☐ Successes [Configure]

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB...	Sent KB/sec	Avg. Bytes
home	700	12074	2420	26093	6881.05	11.57%	23.4/sec	174.33	2.41	7626.2
about us	700	7258	1992	19484	3707.87	0.00%	20.5/sec	206.44	2.54	10334.6
contact-us	700	6490	3463	9231	1034.72	0.00%	18.3/sec	210.63	2.31	11775.6
terms-of-use	700	6722	3784	9212	1046.17	0.00%	17.4/sec	173.93	2.25	10210.7
privacy-policy	700	5999	3789	9231	1200.72	0.00%	17.4/sec	162.66	2.28	9559.5
login	700	5173	2116	9223	1234.26	0.00%	18.8/sec	167.50	2.29	9124.5
register	700	4061	449	6819	1595.08	0.00%	24.1/sec	319.26	3.01	13557.6
TOTAL	4900	6825	449	26093	3922.11	1.65%	87.4/sec	880.19	10.73	10312.7

Response time graph :
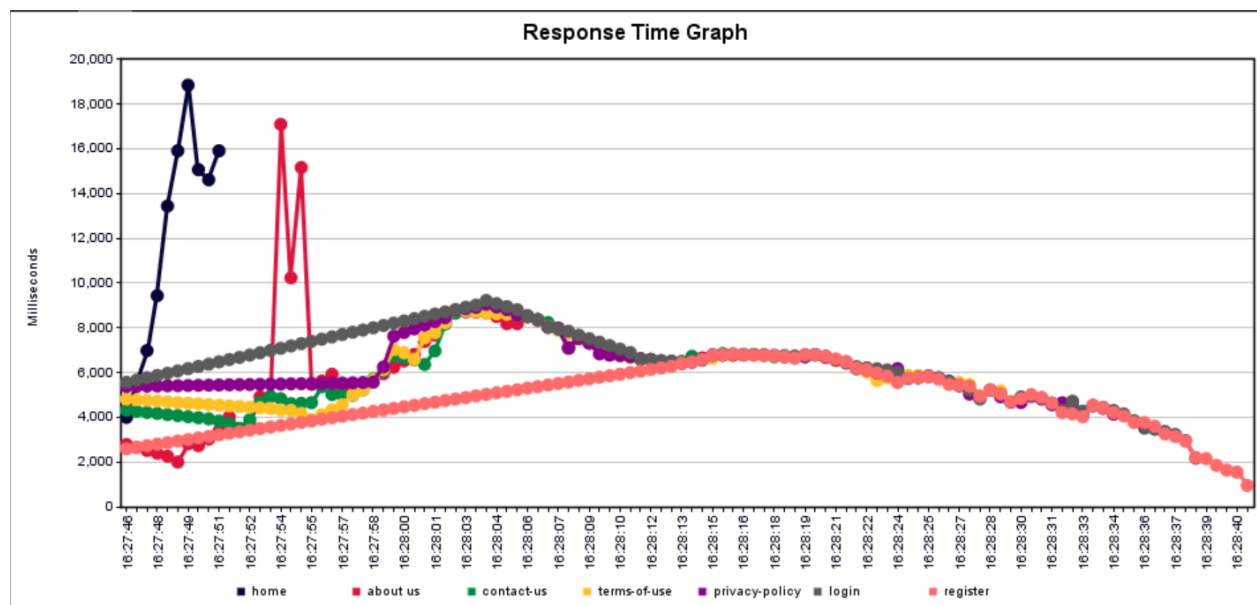
→ For a ramp up time of 5 seconds, we are getting errors on every page up to some extent. For 10s, errors are shown on the home page but for greater than 10 s every page is working perfectly fine with 700 users on each page. So, a total of 4900 users.

As shown in the image below, for a ramp up time of 11s all pages are working fine without any crash at low traffic.

Stress testing :

 In stress testing I have tested the system for different number of threads with ramp-up time equals to zero which means all the users are sending http get requests.

For 100 users :

Summary Report

Name: Summary Report

Comments:

Write results to file / Read from file

Filename [ ] Browse... Log/Display Only: ☐ Errors ☐ Successes [Configure]

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Through...	Receive...	Sent KB/...	Avg. Bytes
home	100	5415	1590	7939	1363.10	0.00%	12.6/sec	101.56	1.46	8265.7
about us	100	2878	1282	4637	654.10	0.00%	11.1/sec	111.92	1.38	10334.4
contact-...	100	2080	1517	4220	390.83	0.00%	10.0/sec	114.91	1.26	11775.9
terms-of...	100	1711	1328	3326	276.44	0.00%	13.8/sec	137.49	1.78	10210.4
privacy-...	100	1460	1267	2687	203.65	0.00%	15.9/sec	148.79	2.09	9559.3
login	100	1379	1174	2792	278.47	0.00%	16.9/sec	150.21	2.06	9124.5
register	100	1259	234	1611	240.69	0.00%	20.9/sec	276.75	2.61	13557.5
TOTAL	700	2312	234	7939	1500.65	0.00%	39.9/sec	405.50	4.98	10404.0

Response Time Graph
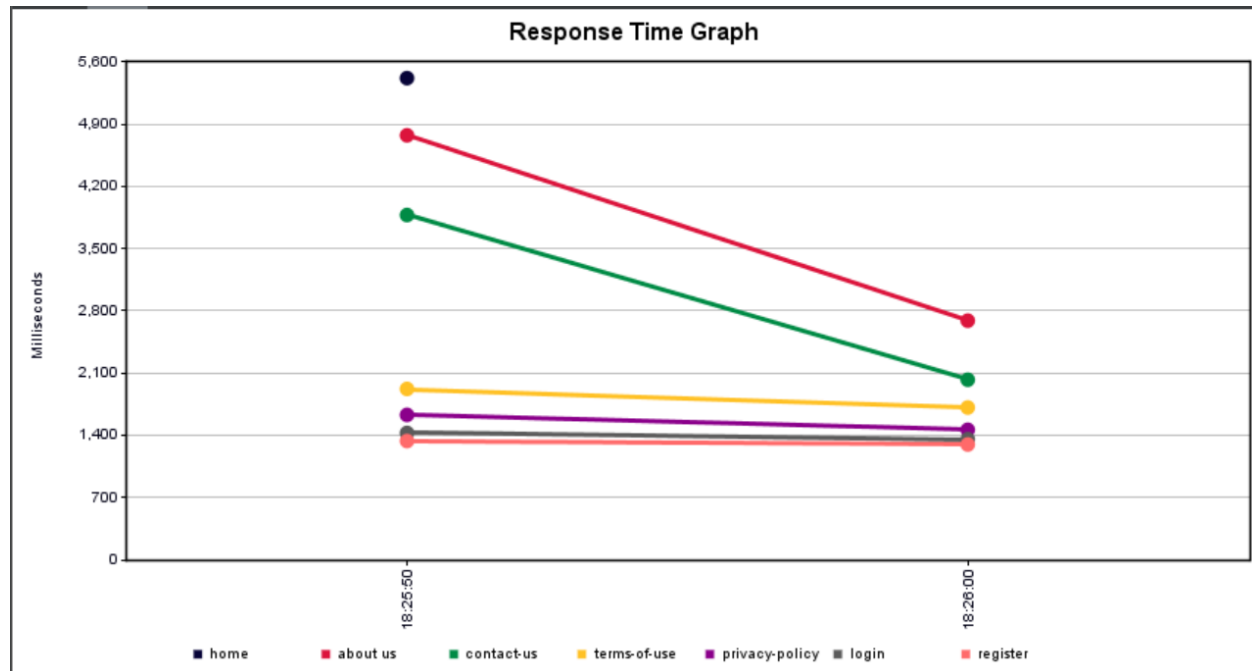
For 200 users :

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB...	Sent KB/sec	Avg. Bytes
home	200	8858	1261	21464	9377.18	36.00%	9.3/sec	55.93	0.69	6160.9
about us	200	2016	507	4101	1560.18	36.00%	8.2/sec	60.97	0.65	7600.9
contact-us	200	2113	658	4109	1489.65	36.00%	7.2/sec	59.60	0.58	8523.1
terms-of-use	200	2134	927	4097	1469.71	36.00%	6.4/sec	46.98	0.53	7521.5
privacy-policy	200	2123	525	4094	1475.16	36.00%	5.8/sec	40.39	0.49	7104.9
login	200	2117	533	4102	1484.48	36.00%	5.3/sec	35.61	0.42	6826.6
register	200	2066	269	4107	1534.98	36.00%	4.9/sec	46.51	0.39	9663.5
TOTAL	1400	3061	269	21464	4483.34	36.00%	30.4/sec	226.35	2.43	7628.8

 Here we can see that if we do stress testing for 200 users we can see that after 128 users the pages are not responding to http requests.
So we can say that 128 users can access all the pages at the same time.
So we can say that the total number of users is 896.

Response Time Graph