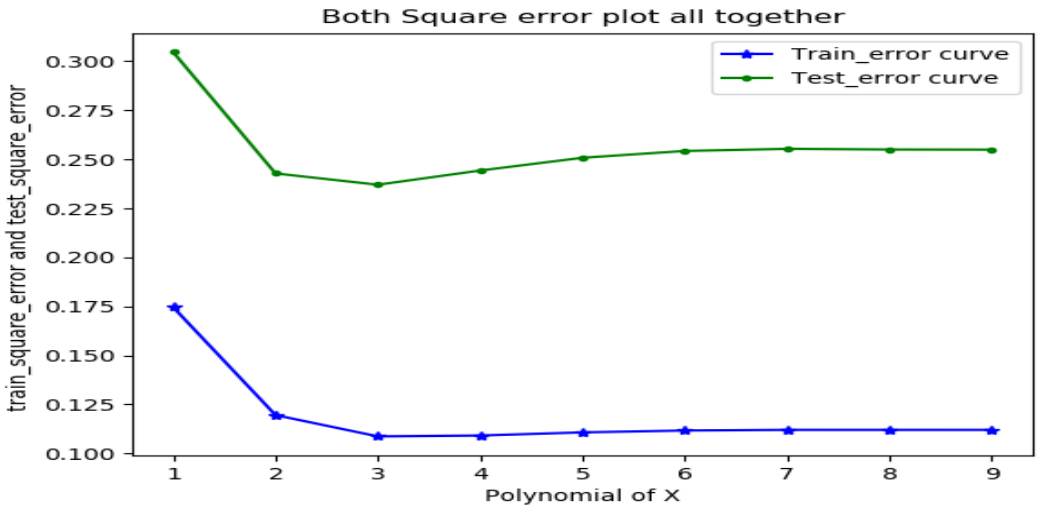
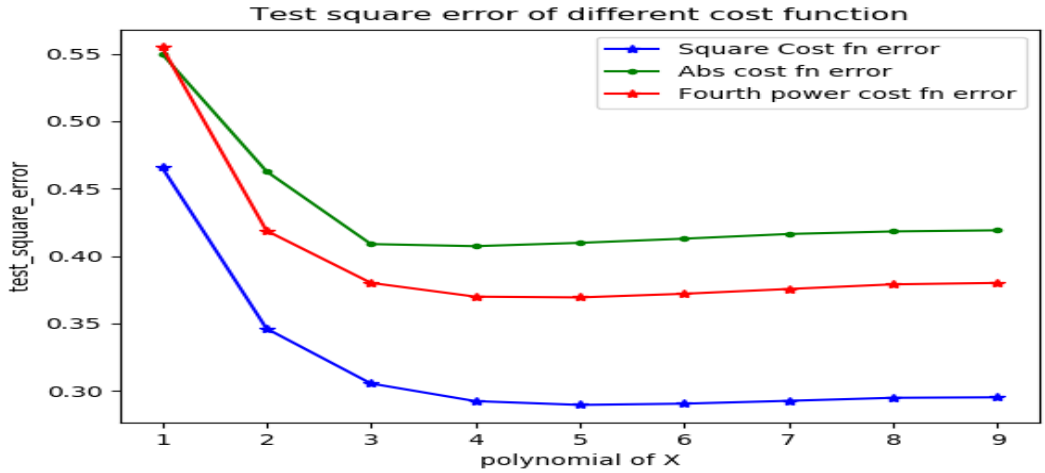
❖ Q.2

b. Ans: n=3, is suitable for the synthetic data set. Because, if we see, below plot, we can have observed that at n=3 polynomial both the test and train error is the lowest among all other polynomials. For, higher degree polynomial may be train error get low but for test data it shows high error.



❖ Q.4

b. Ans: I will prefer Square error cost function among all others cost function. Because if we have observed below plot, we can see, test error for each polynomial is low if we use square cost function for error calculation. Therefore, I will prefer square error cost function



- **Final learned values of the model parameters for each of the parts: 1.C.**
    - For polynomial n=1 estimated W : m -2.090988588826883, b 0.9541366835107351
    - For polynomial n=2 estimated W : m_2_1 -0.11435208443913668, m_2_2 -2.3387056919735416, b 0.7821951778437162
    - For polynomial n=3 estimated W : m_3_1 0.31852295760130567, m_3_2 -1.5681006559306334 ,m_3_3-1.5237073350652997, b 0.7071017053553235
    - For polynomial n=4 estimated W : m_4_1 0.39438607193891895, m_4_2 -1.311389856638333 ,m_4_3 1.2065132125690248,m_4_4 -0.8700750098860243 , b_4 0.6812397205049895
    - For polynomial n=5 estimated W : m_5_1 0.38733542789203756, m_5_2 -1.2286491262323973 ,m_5_3 -1.0848199679151258,m_5_4 -0.7371555200096104, m_5_5 -0.45680113712885667 , b_5 0.6743250813618115
    - For polynomial n=6 estimated W : m_6_1 0.3667674473749682, m_6_2 -1.2061408864638652 ,m_6_3 -1.0400831071373622,m_6_4 -0.6836678155465953, m_6_5 -0.4019289593930629 , m_6_6 -0.21135778983477382, b_6 0.6739482256916859
    - For polynomial n=7 estimated W : m_7_1 0.34890780242086356, m_7_2 -1.2040949430827437 ,m_7_3 -1.0260675204361367,m_7_4 -0.6639748362259761, m_7_5 -0.3802989137917058 , m_7_6 -0.1898579765846415,m_7_7 -0.06872477361050895, b_7 0.6754938744350506
    - For polynomial n=8 estimated W : m_8_1 0.3361320418378707, m_8_2 -1.2083280802076546 ,m_8_3 -1.024164747636651,m_8_4 -0.6586639164384473, m_8_5 -0.3733745592198077 , m_8_6 -0.1823882098133131,m_8_7 -0.06131433151599947,m_8_8 0.012991446987792228,b_8 0.6773440804910171
    - For polynomial n=9 estimated W : m_9_1 0.33461374944868, m_9_2 -1.2089160403951729 ,m_9_3 -1.024041214330085,m_9_4 -0.6581280805496039, m_9_5 -0.3726317309056177 , m_9_6 -0.18156399902305634,m_9_7 -0.0604819057851853,m_9_8 0.013791353226405569,m_9_9 0.001970193318057909,b_9 0.6775811636557787

3.

- Data size==100 For polynomial n=1 estimated W : m -1.5811352838353068, b 0.907924695392384
- Data size==100 For polynomial n=2 estimated W : m_2_1 -0.8622703757415184, m_2_2 -0.9626532742206468
- Data size==100 For polynomial n=3 estimated W : m_3_1 -0.6964625494456707, m_3_2 -0.7224775132936596 ,m_3_3-0.4165338070256561
- Data size==100 For polynomial n=4 estimated W : m_4_1 -0.6844423309449322, m_4_2 -0.6831639390947797 ,m_4_3 -0.3632011022465659,m_4_4 -0.05635903136300818 , b_4 0.7951039814515777
- Data size==100 For polynomial n=5 estimated W : m_5_1 -0.7095655034872513, m_5_2 -0.7075664515824374 ,m_5_3 -0.3842053822299635,m_5_4 -0.0741763658154563, m_5_5 0.16485204671220022 , b_5 0.7949977260355804
- Data size==100 For polynomial n=6 estimated W : m_6_1 -0.7375243687608993, m_6_2 -0.7474109694994839 ,m_6_3 -0.42811968566548886,m_6_4 -0.11910165157288057, m_6_5 0.12024980824439088 , m_6_6 0.29456328654515324, b_6 0.803918216447419
- Data size==100 For polynomial n=7 estimated W : m_7_1 -0.7591715075515263, m_7_2 -0.7858150767211253 ,m_7_3 -0.4748267400502933,m_7_4 -0.16988713121673352, m_7_5 0.06763384759100419 , m_7_6 0.24137853126755576,m_7_7 0.36591241524031654, b_7 0.8157582839522477
- Data size==100 For polynomial n=8 estimated W : m_8_1 -0.7732646516423974, m_8_2 -0.8175658140811755 ,m_8_3 -0.5168386308891242,m_8_4 -0.21782368481203465, m_8_5 0.016328412510025453 , m_8_6 0.18826507016148258,m_8_7 0.3119750582110652,m_8_8 0.40038927512311107,b_8 0.8276239127881371
- Data size==100 For polynomial n=9 estimated W : m_9_1 -0.7733920897536354, m_9_2 -0.8179146101726001 ,m_9_3 -0.5173262725741834,m_9_4 -0.21839725188469353, m_9_5 0.015701855012069763 , m_9_6 0.18760653309124967,m_9_7 0.3112983265710168,m_9_8 0.39970361233534396,m_9_9 0.005710051604790625,b_9 0.8277723232421328
- Data size=1000 For polynomial n=1 estimated W : m -0.9499296057619264, b 0.4655556052442865

- Data size=1000 For polynomial n=2 estimated W : m_2_1 -0.6486242013342036, m_2_2 -0.7024758324315348 , b 0.5564356546240852
- Data size=1000 For polynomial n=3 estimated W : m_3_1 -0.5323410063129128, m_3_2 -0.5652549302833988 ,m_3_3-0.40900901344622625, b 0.5622846465401765
- Data size=1000 For polynomial n=4 estimated W : m_4_1 -0.492946876476091, m_4_2 -0.5116046035257166 ,m_4_3 -0.351306400918284,m_4_4 -0.1932907599983884 , b_4 0.552633014047722
- Data size=1000 For polynomial n=5 estimated W : m_5_1 -0.48455753903364457, m_5_2 -0.4959549302479855 ,m_5_3 -0.33246647879217456,m_5_4 -0.17310825931118407, m_5_5 -0.04837917770589653 , b_5 0.5435134925402265
- Data size=1000 For polynomial n=6 estimated W : m_6_1 -0.4880221897252975, m_6_2 -0.4970631391455356 ,m_6_3 -0.33202905422569734,m_6_4 -0.1716806469304057, m_6_5 -0.04631399727809493 , m_6_6 0.04593136428114092, b_6 0.537768875904368
- Data size=1000 For polynomial n=7 estimated W : m_7_1 -0.49529896379001315, m_7_2 -0.5049983319488193 ,m_7_3 -0.33983491356706125,m_7_4 -0.17915161241264646, m_7_5 -0.05340498297866387 , m_7_6 0.039214047069205386,m_7_7 0.10602357635261465, b_7 0.535100164632703
- Data size=1000 For polynomial n=8 estimated W : m_8_1 -0.5030657447214856, m_8_2 -0.5151211097285519 ,m_8_3 -0.350829651345848,m_8_4 -0.190406426153873, m_8_5 -0.06462968571310959 , m_8_6 0.028166531526759235,m_8_7 0.09522887961248169,m_8_8 0.14330345887141405,b_8 0.5346508921704362
- Data size=1000 For polynomial n=9 estimated W : m_9_1 -0.5030749369342473, m_9_2 -0.5151335656428332 ,m_9_3 -0.3508434579949661,m_9_4 -0.19042075656401558, m_9_5 -0.0646441274302486 , m_9_6 0.028152200069855724,m_9_7 0.09521478128499694,m_9_8 0.14328966150881634,m_9_9 0.0002046995164411662,b_9 0.534651052064932
- Data size=10000 For polynomial n=1 estimated W : m -0.936028904529699
- Data size=10000 For polynomial n=2 estimated W : m_2_1 -0.6421185025550803, m_2_2 -0.7062147246916998 , b 0.5262770365731261

- Data size=10000 For polynomial n=3 estimated W : m_3_1 -0.5247221905074176, m_3_2 -0.569434937697972 ,m_3_3-0.42768116669528905, b 0.5341663648933341
- Data size=10000 For polynomial n=4 estimated W : m_4_1 -0.48182186849585934, m_4_2 -0.5122904997447553 ,m_4_3 -0.3669658922671635,m_4_4 -0.22062823456719297 , b_4 0.5257154454744647
- Data size=10000 For polynomial n=5 estimated W : m_5_1 -0.4698171447116278, m_5_2 -0.49226985055514205 ,m_5_3 -0.34373067674495544,m_5_4 -0.19628711825137488, m_5_5 -0.07985242688048946 , b_5 0.5169390580834375
- Data size=10000 For polynomial n=6 estimated W : m_6_1 -0.47026846930024674, m_6_2 -0.4892776517689221 ,m_6_3 -0.33884426015292013,m_6_4 -0.19036453556013577, m_6_5 -0.07337857688828699 , m_6_6 0.013236375695476567, b_6 0.5109613884472055
- Data size=10000 For polynomial n=7 estimated W : m_7_1 -0.47526429590447594, m_7_2 -0.4937495848948068 ,m_7_3 -0.3426577951284507,m_7_4 -0.1936135953558401, m_7_5 -0.07617087194976994 , m_7_6 0.010811320226561054,m_7_7 0.07387592003512149, b_7 0.5077234811633698
- Data size=10000 For polynomial n=8 estimated W : m_8_1 -0.4814075163982959, m_8_2 -0.5010953018920951 ,m_8_3 -0.35026610055910024,m_8_4 -0.20114831574894482, m_8_5 -0.08349768008574919 , m_8_6 0.003744908512549464,m_8_7 0.06708565487711521,m_8_8 0.11269522928136504,b_8 0.5065372979523651
- Data size=10000 For polynomial n=9 estimated W : m_9_1 -0.4814082614885397, m_9_2 -0.5010962216697812 ,m_9_3 -0.3502670698068919,m_9_4 -0.20114928726212275, m_9_5 -0.08349863359038297 , m_9_6 0.0037439819723968843,m_9_7 0.06708475895498514,m_9_8 0.11269436498966734,m_9_9 1.6099194998523913e-05,b_9 0.506537205204056