The Final Examination Paper

Applied Numerical Method in Engineering and Science

(Release the paper on 2021,7,23, and submit your full answer on 2021,7,31)

* Write your name and ID (use the official cover).
* *Show all necessary work for full credit.* Your full answer include a word document point to point, and all programs also are demanded.
* Follow the instruction for each problem.

**Background and data:** Isle Royale National Park is a 210-square mile archipelago composed of a single large island and many small islands in Lake Superior. Moose arrived around 1900, and by 1930, their population approached 3000, ravaging vegetation. In 1949, wolves crossed an ice bridge from Ontario. Since the late 1950s, the numbers of the moose and wolves have been tracked. The following vectors, Year, Moose and Wolves are given.

Year=1959:2006;

Moose=[563 610 628 639 663 707 733 765 912 1042 1268 1295 1439 1493 1435 1467 1355 1282 1143 1001 1028 910 863 872 932 1038 1115 1192 1268 1335 1397 1216 1313 1590 1879 1770 2422 1163 500 699 750 850 900 1100 900 750 540 450];

Wolves=[20 22 22 23 20 26 28 26 22 22 17 18 20 23 24 31 41 44 34 40 43 50 30 14 23 24 22 20 16 12 12 15 12 12 13 17 16 22 24 14 25 29 19 17 19 29 30 30];

**Tasks:**

(1) Use the data of the moose from 1959 to 1973, show the polynomial fitting results. You need give the best order polynomial and show the error. And you should give an estimation about the numbers of moose before 1959.

(2) Based on the data in question (1), use numerical differential to give the grouth rate of moose.

(3) You can use the model (22.49) and (22.50) on Page 578 of textbook to describe the change of the two populations over time t. please show how to create the model and the meanings of all parameters.

(4) Use the parameters a=0.23, b=0.0133, c=0.4 and d=0.0004, solve the system of ordinary differential equations and compare your simulation with the data and determine the sum of the squares of the residuals between your model and the data for both the moose and wolves.

(5) Develop a curve fitting mothed based on the data and model to determine the four parameters a, b, c and d. please show your idea, method, algorithm, code and results.

(6) In (22.49), the second part of the rhs term –bxy can be viewed as the number of moose eaten by wolves, please show the tatol number of moose eaten from 1959 to 1989.

(7) Use the result of question (4), you can get the period T of the periodical solution. Select the interval [1975, 1975+T], give the mean numbers of moose and wolves in the period. Use data in the period, compute the maximum and minimum numbers of moose and wolves in the period. Compare between the estimation and the estimation numbers by question (5).

(8) For the ODE with given parameters in the question (4), use the shooting method of ODE solve the system of equations with boundary value moose(1959) = 1028 and wolves(2010) = 25.