

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED MATHEMATICS

SMA 5274 SPREADSHEET MODELLING

JANUARY 2008

Time : 3 hours

Answer **ALL** questions.

SECTION A

Answer ALL questions from this section. Total Marks: 50

Use **EXCEL** to answer each of the following questions and write the answer in the answer book provided. At the end of your **EXCEL** session, save your worksheet under the name C\exam\ E - - - - .XLS, where - - - - are the last four digits of your registration number.

A1. A disease model is described by the following system of differential equations

$$ds/dt = \mu - \beta is + \alpha r$$

$$di/dt = \beta is - \gamma i$$

$$dr/dt = \gamma i - \alpha r$$

where s are susceptible individuals, i are infected individuals, r are the recovered individuals, μ is the recruitment rate, β is the contact rate, γ is the recovery rate and α is the rate of loss of immunity. Given that $s(0) = 0.8$, $i(0) = 0.1$, $r(0) = 0.1$, $\mu = 0.029$, $\beta = 0.45$, $\gamma = 0.125$ and $\alpha = 0.05$ solve this system numerically with a step length of 0.1. Plot the graphs of s , i and r as functions of time on the same chart. Investigate the behaviour of i for $\beta = 0.1, 0.2, 0.4, 0.6, 0.8$ and 1.0 and comment. Label the graph and the axes appropriately. [15]

Product	Material 1	Material 2	Material 3
Fuel additive	0.3	0	0.5
Solvent base	0.4	0.1	0.2
Amount of available production	18 tons	3 tons	19 tons

A2. A company produces a variety of chemical based products. In the production process, three raw materials are used to produce two products, a fuel additive and solvent base. The fuel additive is sold to oil companies and used in production of gasoline and related fuels. The solvent base is sold to a variety of chemical firms and is used in both home and industrial cleaning products. The three raw materials are blended to form the fuel additive and solvent base as indicated in the following table:

Let X_1 be the number of tons of fuel additive that the firm produces, and X_2 be the number of tons of solvent base that the firm produces. Firm's profit contribution for two products X_1, X_2 are \$35 and \$30 respectively. Formulate a linear programming model to maximise profit and solve it using Solver. [15]

A3. The following data represents monthly income and expenditure (in dollars) for a company for first six months of the year 2007.

Month	Income	Expenditure
Jan	2345	1765
Feb	2543	2109
Mar	2628	1980
Apr	2812	2187
May	2990	2256
Jun	3215	2534

- For the next six months, income is expected to rise by 10% each month and expenditure is expected to rise by 12% each month. Hence estimate the total income and total expenditure for the year 2007. [5]
- Tax will be taken as a percentage of income. Create a column showing the profit after tax. Hence find the mean monthly profit after a tax of 10% and a tax of 15%. [5]
- Use the Data Analysis Tool to find the median and the skewness of the monthly income and expenditure. [5]

A4. Solutions are required to the equation

$$x \cos(2x + 1) = e^{(1-x)}(x + 1)^3$$

between $x = 0$ and $x = 10$. By plotting graphs of $y = x \sin 2x$ and $y = e^{-x}(x + 1)^3$, find these solutions to an accuracy of 0.1. Label the graph and the axes appropriately. [5]

SECTION B

Answer ALL questions from this section. Total Marks: 50

Use **VBA (EXCEL)** to answer each of the following questions and write (where necessary) your answers in the answer book provided. At the end of your **VBA (EXCEL)** session, save your worksheet under the name C:\exam\ V - - - -.XLS, where - - - - are the last four digits of your registration number.

- B5.** (a) You are required to develop a simple student registration program to record the data related to students. The user will enter the name, surname and age information of the student to some textboxes. The gender of the student will be initialized by using optionbuttons while the foreign language will be by checkboxes. Finally the student data will be added to a listbox by clicking a command button. You are required to create a user form of height 270 and width 360. Use your student registration number to label the user form. Add the following toolbox controls, with the properties summarized below, onto your user form:

Control	Caption	Font	Width	Height	Top	Left
Label	STUDENT REGISTRATION FORM	TimesNewRomans 14(bold italic)	330	20	10	6
Label	Name	Tahoma 8(bold)	45	20	55	6
Label	Surname	Tahoma 8(bold)	45	20	90	6
Label	Age	Tahoma 8(bold)	45	20	120	6
Label	Students Registered	Tahoma 10(italic)	170	20	35	170
Txtbx	-	-	100	20	55	60
Txtbx	-	-	100	20	85	60
Txtbx	-	-	60	20	115	60
Frame	Gender	Tahoma 8(bold)	150	35	150	6
Frame	Foreign Language 8(bold)	Tahoma 8(bold)	150	35	205	6
OptBn	Male	Tahoma 8(regular)	40	20	6	6
OptBn	Female	Tahoma 8(regular)	45	20	6	85
ChckBx	English	Tahoma 8(regular)	50	20	6	6
ChckBx	German	Tahoma 8(regular)	50	20	6	85
LstBx	-	-	180	150	60	170
CmdBx	Add to List	Tahoma 8(regular)	60	25	220	165
CmdBx	Remove	Tahoma 8(regular)	55	25	220	230
CmdBx	Quit	Tahoma 8(regular)	55	25	220	288

(TxtBx represents textbox, ChckBx represents checkbox, LstBx represents listbox, OptBx represents option box while CmdBx represents commandbox). [20]

(b) Add appropriate code onto the “Add to List”, “Remove” and “Quit” command buttons. [10]

B6. In order for a fund manager to assess the performance of the fund’s assets, he calculates the Money-Weighted-Rate-of-Return (MWWR) realized over the full year to 31 December of each year. He uses the formula:

$$F_0 \times (1 + i) + C \times (1 + i)^{0.5} = F_1,$$

where F_0 = opening balance of the fund assets,

C = net new money injected over the year e.g. premium contributions, injections by the Sponsoring Employer in setting off deficits,

F_1 = closing balance of the fund assets and

i = MWWR over the year. F_0 , F_1 and C are given each time MWWR is computed.

As an alternative to the Goal Seek function of Ms excel, write a VBA code applying the Newton-Raphson method of Numerical analysis, i.e.

$$x_{r+1} = x_r - \frac{f(x_r)}{f'(x_r)}$$

to compute the investment return, i . Include objects such as the command button to present a user-friendly interface to the fund manager. [13]

B7. Write a procedure function that solves the following quadratic equation:

$$ax^2 + bx + c = 0$$

(Make use of input boxes to capture the values of a, b and c . The final solution(s) should be rounded off to 2 decimal places). [7]

END OF QUESTION PAPER