Tutorial Letter 101/0/2023

Applied Linear Algebra

APM1513

Year module

Department of Mathematical Sciences

IMPORTANT INFORMATION:

Please register on myUnisa, activate your myLife e-mail account and make sure that you have regular access to the myUnisa module website, APM1513-2023-0, as well as your group website.

BAR CODE

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1 INTRODUCTION

Dear Student

We are pleased to welcome you to this module and hope that you will find it both interesting and rewarding. We shall do our best to make your study of this module successful. You will be well on your way to success if you start studying early in the year and resolve to do the assignments properly.

Because this is a fully online module, you will need to use myUnisa to study and complete the learning activities for this module. Visit the website for APM1513 on myUnisa frequently. The website for your module is APM1513-2023.

1.1 Purpose

Owing to the nature of this module, you can read about the module and find your study material online. Go to the website at https://my.unisa.ac.za and log in using your student number and password. Click on "myModules" at the top of the web page and then on "Sites" in the top right corner. In the new window, click on the grey Star icon next to the modules you want displayed on your navigation bar. Close the window in the top right corner. Then select the option "Reload to see your updated favourite sites". Now go to your navigation bar and click on the module you want to open.

We wish you every success with your studies!

2 OVERVIEW OF APM1513

2.1 Purpose

This module will be useful to students interested in developing the basic skills in linear algebra as well as to apply the software package “Octave” for all calculations. Note that we are using the latest version of “Octave” and this will be part of your study material which you will receive at registration for this module. Students credited with this module will have an understanding of the basic ideas of linear algebra and be able to apply the basic techniques for handling systems of linear equations, matrices, determinants and eigenvectors and linear programming. In all these topics you will be able to apply the software package Octave or Matlab to do all calculations.

2.2 Outcomes

The broad outcomes for this module are

- To solve systems of linear equations with the use of Octave or Matlab.
- To perform basic matrix operations.
- To use iterative methods to find appropriate solutions for systems
- To know what is meant by the eigenvalue equation, to be able to calculate the eigenvalue of a matric and its corresponding eigenvector and to be able to write the Octave or Matlab code to do so.

- To be able to solve linear programming problems and to give a geometric interpretation by means of an illustration in the two or more dimensional cases by using your software.

Specific outcomes are listed in the study guide.

3 CURRICULUM TRANSFORMATION

Unisa has implemented a transformation charter, in terms of which the university has placed curriculum transformation high on the teaching and learning agenda. Curriculum transformation includes student-centred scholarship, the pedagogical renewal of teaching and assessment practices, the scholarship of teaching and learning, and the infusion of African epistemologies and philosophies. All of these will be phased in at both programme and module levels, and as a result of this you will notice a marked change in the teaching and learning strategy implemented by Unisa, together with the way in which the content is conceptualised in your modules. We encourage you to embrace these changes during your studies at Unisa in a responsive way within the framework of transformation

4 LECTURER(S) AND CONTACT DETAILS

4.1 Lecturer(s)

The primary lecturer for this module is Prof. AS Kubeka:

Prof. AS Kubeka
Tel: +2711 670 9157
Room no: 647
GJ Gerwel Building
Florida Campus
e-mail: kubekas@unisa.ac.za

Prof. JM. Manale
Tel: (011) 471 2912
Room no: 646
GJ Gerwel Building
Florida Campus
e-mail: manaljm@unisa.ac.za

4.2 Department

You can contact the Department of Mathematical Sciences as follows:

Department of Mathematical Sciences
Office: GJ Gerwel Building, Room 6-66
Telephone: +2711 670 9147
Fax: +2711 670 9171
E-mail: mathsciences@unisa.ac.za

4.3 University

Always use your student number when you contact the University.

Contact addresses of the various administrative departments appear on the Unisa website: http://www.unisa.ac.za/Student-enquiries.

Please include the student number in all correspondence

5 RESOURCES

5.1 Prescribed books

There are no prescribed books for this module.

5.2 Recommended books

You may consult the following publication in order to broaden your knowledge of APM1513. A **limited** number of copies is available in the Library.

- B.D. Hahn *Essential MATLAB for Scientists and Engineers* (Pearson Education South Africa, Cape Town, 2002)
- Ayres, Frank: Schaum's Outline of Theory and problems of Matrices, McGraw-Hill, New York, 1974.
- Cullen, Charles G.: Matrices and Linear Transformations, Addison-Wesley, Reading, MASS., 1972.
- Johnson, Lee W.: Introduction to Linear Algebra (2^{nd} or earlier editions), Addison-Wesley, Reading, MASS., 1989.
- Knopp, Paul J.: Linear Algebra, an Introduction, Hamilton Publishing Co., Santa Barbara, CALIF., 1974.
- Lipschutz, Seymour: Schaum's Outline of Theory and Problems of Linear Algebra, McGraw-Hill, New York, 1968.

- Nering, Evar D.: Elementary Linear Algebra, W.B. Saunders Publishing Co., Philadelphia, 1974.
- Nicholson,W.K.: Linear Algebra with Applications, (3rd edition), PWS Publishing Company, Boston.
- Kolman, Bernard & Hill, David R.: Introductory Linear Algebra; An Applied First Course (8th edition or earlier), Prentice Hall, 2005.
- Grossman, Stanley I.: Elementary Linear Algebra (any edition), Wadsworth Publishing Co., Belmont, CA., 1991.

NOTE: Do not feel that you **should** study from these books, simply because we have provided you with this list. Sometimes, however, if one really gets bogged down on a particular section or part of the work, a different presentation might just be what is needed to get going again.

Recommended books can be requested online, via the Library catalogue.

5.3 Electronic Reserves (e-Reserves)

There are no e-Reserves for this module.

5.4 Library services and resources

The Unisa Library offers a range of information services and resources:

- for detailed Library information go to http://www.unisa.ac.za/sites/corporate/default/Library
- for research support and services (e.g. personal librarians and literature search services) go to
  http://www.unisa.ac.za/sites/corporate/default/Library/Library-services/Research-support
- For library training for undergraduate students, go to
  http:///www.unisa.ac.za/sites/corporate/default/Library/Library-services/Training

The Library has created numerous Library guides:

http://libguides.unisa.ac.za

Recommended guides:

- Request and download recommended material:
  http://libguides.unisa.ac.za/request/request
- Postgraduate information services:
  http://libguides.unisa.ac.za/request/postgrad
- Finding and using library resources and tools:
  http://libguides.unisa.ac.za/Research_skills

- Frequently asked questions about the Library:
  http://libguides.unisa.ac.za/ask
- Services to students living with disabilities:
  http://libguides.unisa.ac.za/disability

6 STUDENT SUPPORT SERVICES

The *Study @ Unisa* brochure is available on myUnisa: www.unisa.ac.za/brochures/studies

This brochure contains important information and guidelines for successful studies through Unisa.

If you need assistance with regard to the myModules system, you are welcome to use the following contact details:

- Toll-free landline: 0800 00 1870 (Select option 07 for myModules)
- E-mail: mymodules22@unisa.ac.za or myUnisaHelp@unisa.ac.za

You can access and view short videos on topics such as how to view your calendar, how to access module content, how to view announcements for modules, how to submit assessment and how to participate in forum activities via the following link: https://dtls-qa.unisa.ac.za/course/view.php?id=32130

• You will be able to immediately download all your study material from this site, in electronic format.
• You can use the discussion forum to communicate with your fellow students.

Registered Unisa students get a free myLife e-mail account. Important information, notices and updates are sent exclusively to this account. Please note that it can take up to 24 hours for your account to be activated after you have claimed it. Please do this immediately after registering at Unisa, by following this link: myLifeHelp@unisa.ac.za

Your myLife account is the only e-mail account recognised by Unisa for official correspondence with the university, and will remain the official primary e-mail address on record at Unisa. You remain responsible for the management of this e-mail account.

7 STUDY PLAN

Study plan	Year Module
Outcomes 1.1 to 3.3 to be achieved by	15 May
Outcomes 3.4 to 5.6 to be achieved by	22 August
Outcomes 6.1 to 6.6 to be achieved by	15 September
Revision	25 September

See the brochure *my Studies @ Unisa* for general time management and planning skills.

8 HOW TO STUDY ONLINE

8.1 What does it mean to study fully online?

There are no practicals for this module.

9 ASSESSMENT

9.1 Assessment criteria

There are three written assignments and one examination.

Examination admission.

Please note that lecturers are not responsible for examination admission, and ALL enquiries about examination admission should be directed by e-mail to exams@unisa.ac.za

Note that your marks for the assignments contribute 20% to your final mark (the remaining 80% is contributed by the final examinations).

9.2 Assessment plan

- To complete this module, you will be required to submit three assessments.
- All information about when and where to submit your assessments will be made available to you via the myModules site for your module.
- Due dates for assessments, as well as the actual assessments are available on the myModules site for this module.
- To gain admission to the examination, you will be required to submit Assignment 01.
- You will receive examination information via the myModules sites. Please watch out for announcements on how examinations for the modules for which you are registered will be conducted.

9.3 Assignment numbers

9.3.1 General assignment numbers

The assignments are numbered as 01, 02 and 03.

9.4 Assignment due dates

The closing dates for submission of the assignments are:

Assignment no	Fixed closing date
01	15 May 2023
02	22 August 2023
03	15 September 2023

- Please start working on your assessments as soon as you register for the module.
- Log on to the myUnisa site for this module to obtain more information on the due dates for the submission of the assessments.

9.5 Submission of assignments

- Unisa, as a comprehensive open distance e-learning institution (CODeL), is moving towards becoming an online institution. You will therefore see that all your study material, assessments and engagements with your lecturer and fellow students will take place online. We use myUnisa as our virtual campus.
- The myUnisa virtual campus will offer students access to the myModules site, where learning material will be available online and where assessments should be completed. This is an online system that is used to administer, document, and deliver educational material to students and support engagement between academics and students.
- The myUnisa platform can be accessed via https://my.unisa.ac.za. Click on the myModules 2023 button to access the online sites for the modules that you are registered for.
- The university undertakes to communicate clearly and as frequently as is necessary to ensure that you obtain the greatest benefit from the use of the myModules learning management system. Please access the announcements on your myModules site regularly, as this is where your lecturer will post important information to be shared with you.
- When you access your myModules site for the module/s you are registered for, you will see a welcome message posted by your lecturer. Below the welcome message you will see the assessment shells for the assessments that you need to complete. Some assessments may be multiple choice, some tests, others written assessments, some forum discussions, and so on. All assessments must be completed on the assessment shells available on the respective module platforms.

- To complete quiz assessments, please log on to the module site where you need to complete the assessment. Click on the relevant assessment shell (Assessment 1, Assessment 2, etc.). There will be a date on which the assessment will open for you. When the assessment is open, access the quiz online and complete it within the time available to you. Quiz assessment questions are not included in this tutorial letter (Tutorial Letter 101) and are only made available online. You must therefore access the quiz online and complete it online where the quiz has been created.
- It is not advisable to use a cell phone to complete the quiz. Please use a desktop computer, tablet or laptop when completing the quiz. Students who use a cell phone find it difficult to navigate the Online Assessment tool on the small screen and often struggle to navigate between questions and successfully complete the quizzes. In addition, cell phones are more vulnerable to dropped internet connections than other devices. If at all possible, please do not use a cell phone for this assessment type.
- For written assessments, please note the due date by which the assessment must be submitted. Ensure that you follow the guidelines given by your lecturer to complete the assessment. Click on the submission button on the relevant assessment shell on myModules. You will then be able to upload your written assessment on the myModules site of the modules that you are registered for. Before you finalise the upload, double check that you have selected the correct file for upload. Remember, no marks can be allocated for incorrectly submitted assessments.

9.6 The assessments

As indicated in section 9.2, you need to complete three assessments for this module.

CALCULATION OF FINAL MARK
Your final mark will be composed of 80% for your exam mark and 20% of your year mark.

10 10. ACADEMIC DISHONESTY

10.1 Plagiarism

Plagiarism is the act of taking the words, ideas and thoughts of others and presenting them as your own. It is a form of theft. Plagiarism includes the following forms of academic dishonesty:

- Copying and pasting from any source without acknowledging the source.
- Not including references or deliberately inserting incorrect bibliographic information.
- Paraphrasing without acknowledging the original source of the information.

10.2 Cheating

Cheating includes, but is not limited to, the following:

- Completing assessments on behalf of another student, copying the work of another student during an assessment, or allowing another student to copy your work.

- Using social media (e.g. WhatsApp, Telegram) or other platforms to disseminate assessment information.
- Submitting corrupt or irrelevant files, this forms part of examination guidelines
- Buying completed answers from so-called "tutors" or internet sites (contract cheating).

10.3 For more information about plagiarism, follow the link below:

https://www.unisa.ac.za/sites/myunisa/default/Study-@-Unisa/Student-values-and-rules

11 STUDENTS LIVING WITH DISABILITIES

The Advocacy and Resource Centre for Students with Disabilities (ARCSWiD) provides an opportunity for staff to interact with first-time and returning students with disabilities. If you are a student with a disability and would like additional support or need additional time for assessments, you are invited to contact (name and e-mail address of the lecturer must be inserted) to discuss the assistance that you need.

12 FREQUENTLY ASKED QUESTIONS

The *Study @ Unisa* brochure contains an A-Z guide of the most relevant study information.

13 SOURCES CONSULTED

No other sources were consulted in preparing this tutorial letter.

14 GETTING STARTED: INSTALLATION OF OCTAVE

This module is mainly about the use of the mathematical software package Octave or MATLAB, and in order to take the module it is a requirement that

- You have regular access to a computer, for example at home, at work, or at a Unisa computer laboratory
- If it is not your own (or Unisa's) computer, you have permission to install the software Octave or MATLAB onto it
- You have had some prior experience in computer programming.

Your study package contains a CD, and when you open the CD you will see that it contains the following directories, sub-directories and files

- StudyMaterial
  - TL501.pdf
  - TL101.pdf

- Octave
  - Windows
    - octave-3.0.0-setup.exe
    - octave-3.0.1-setup.exe
  - Linux
    - octave-3.0.0.tar
    - octave-3.0.1.tar
  - Mac
    - octave-3.0.0-i386.dmg
    - octave-3.0.1-i386.dmg
    - octave-3.0.1-ppc.dmg

We include both the latest (in August 2008) available version of Octave as well as the version (3.0.0) that was used in writing the Study Guide. You should install the latest version, but if you notice any discrepancies between the behaviour of this version and that described in the Study Guide, you could re-try with version 3.0.0. If you like, you can also go on the internet to see if there is an even later version of Octave. The Octave home page is http://www.octave.org, and the repository with various versions of Octave is http://www.gnu.org/software/octave/download.html

14.1 Windows

Our experience has been that the installation of Octave is easy and straightforward. Just insert the CD into your computer's CD drive, open it using Windows Explorer, and double click the .exe file you want to install. The installation window will open and unless you have experience in systems programming you should just accept the default options. The only exception is the page that asks you to choose a graphics backend. The default option is a development package based on java, but we have found that on some machines this option is unstable. So we suggest that you click on the stable version based on gnuplot and use that instead. It is as simple as that!

14.2 Linux and Mac

Versions of Octave for installation on a Linux or Mac machine are included on the CD, but your lecturers can provide only limited help if you experience system-related problems with these versions.

14.3 Unisa computer laboratories

If you are using a Unisa computer laboratory, you should find that Octave has already been installed and the Octave icon will be on the Desktop.

14.4 MATLAB

MATLAB is a commercial software product that has to be purchased, whereas Octave is available free of charge. Although there are occasional differences, the syntax of the two programming systems is almost identical. In some advanced, specialized applications we have found that MATLAB was able to solve a problem but Octave was unsuccessful. However, for the introductory purposes

of this module, Octave is quite sufficient. If you wish, for example if the computer that you are using for this module already has MATLAB installed, then you are welcome to use MATLAB rather than Octave; but please be aware that there will be minor syntactical and layout differences between MATLAB and the notes in the Study Guide. Otherwise, we would suggest that you work entirely with Octave.

15 IN CLOSING

We hope that you will enjoy this module and we wish you success with your studies.

Your APM1513 lecturers

ADDENDUM A: ASSIGNMENTS

APM1513
ASSIGNMENT 01
Getting started with MATLAB/Octave.
Introduction to programming with MATLAB/Octave.
Use of MATLAB/Octave to solve linear systems of equations.
FIXED CLOSING DATE: 15 May 2023

- The assignment must be answered using Octave (or MATLAB), and for each question you must include your computer code including any .m files used, as well as the output. These should be copied and pasted into a word processing system, and you should produce a single file containing all the answers to the questions in the assignment, which can then be printed out, for hard copy submission, or submitted electronically via *MyUnisa*.
- We **will not accept** hand-written solutions, or anything that does not contain Octave (or MATLAB) code and output.
- In many questions, as well as the computer code and output, you will need to include some form of comment in your answer. This should be in the form of complete sentences that make sense to the reader.
- You should use a fixed space font such as courier for computer code and output, and something else for discussion.
- Question 1 does not carry any marks, but is **compulsory** as it enables us to check that your student number was actually used in an Octave (or MATLAB) session.
- There are 60 marks distributed as shown, and 60 marks = 100%.

QUESTION 1

Enter the following two commands, and copy and paste the output as your answer
> **rand("state",student_number0918);**
> **rand(1)**
where student_number0918 is your student number with "0918" at the end and with "-" removed. For example, if your student number is 123-456-7, you would enter
> **rand("state",12345670918);**
> **rand(1)**

QUESTION 2

The command *etime* takes as input two 6-dimensional row vectors. Use the help facility for *etime* and emphasize to find out more. Then find the number of seconds between 08h 27m 30s on 18 February 2003, and 19h 35m 09s on 13 August 2008. [10]

QUESTION 3

Evaluate the series

$$1-3+5-7+9-...+1001.$$

[10]

QUESTION 4

Evaluate the series $\sum_{n=1}^{\infty} u_n$ in which u_n is not known explicitly but is given in terms of a recurrence relation. You should stop the summation when $|u_n| < 10^2$

$$u_{n+1} = (u_{n-1})^2 + (u_n)^{1.5} \text{ with } u_1 = 0.1,\ u_2 = 0.2$$

[20]

QUESTION 5

Evaluate the series $\sum_{n=1}^{\infty} u_n$ in which u_n is not known explicitly but is given in terms of a recurrence relation. You should stop the summation when $|u_n| < 10^{-18}$

$$u_{n+1} = (u_n)^2 \text{ with } u_1 = 0.5$$

[10]

QUESTION 6

Given

$$x_k = \frac{L_k}{L_k\sqrt{L_k + 20\pi^2}}$$

where

$$L_k = \frac{1}{1+\frac{1}{k}},\ k = 1...50$$

find

$$S = \mathbf{x}.\mathbf{L} = \sum_{K=1}^{50} x_k L_k$$

[10]

Total [60]

APM1513
ASSIGNMENT 02
Use of MATLAB/Octave to solve linear systems of equations.
Overdetermined and underdetermined systems of linear equations.
Eigenvalues, eigenvectors and matrix diagonalization.
FIXED CLOSING DATE: 22 August 023

- The assignment must be answered using Octave (or MATLAB), and for each question you must include your computer code including any .m files used, as well as the output. These should be copied and pasted into a word processing system, and you should produce a single file containing all the answers to the questions in the assignment, which can then be printed out, for hard copy submission, or submitted electronically via *MyUnisa*.
- We **will not accept** hand-written solutions, or anything that does not contain Octave (or MATLAB) code and output.
- In many questions, as well as the computer code and output, you will need to include some form of comment in your answer. This should be in the form of complete sentences that make sense to the reader.
- You should use a fixed space font such as courier for computer code and output, and something else for discussion.
- Question 1 does not carry any marks, but is **compulsory** as it enables us to check that your student number was actually used in an Octave (or MATLAB) session.
- There are 100 marks distributed as shown, and 100 marks = 100%.

QUESTION 1

Enter the following two commands, and copy and paste the output as your answer
> **rand("state",student_number0915);**
> **rand(1)**
where student_number0915 is your student number with "0915" at the end and with "-" removed. For example, if your student number is 123-456-7, you would enter
> **rand("state",12345670915);**
> **rand(1)**

QUESTION 2

Solve the following systems of equations, using the $A\backslash b$ construct, as well as the Gauss-Seidel method with a tolerance of $10-7$ (in some cases convergence may not occur).

(a) $2x_1 - x_2 + 3x_3 = 8$
$4x_1 + 2x_2 - 5x_3 = -9$
$6x_1 + 3x_2 + x_3 = 12$ [5]

(b) $10x_1 + x_2 + 2x_3 = 3$
$x_1 + 10x_2 - x_3 = 1.5$
$2x_1 + x_2 + 10x_3 = -9$ [5]

QUESTION 3

Modify the function file gauss_seidel.m to produce a new function file Jacobi.m that implements the jacobi method. Now use the Jacobi method to solve example 3.2.1, i.e.
$12x_1 - 3x_2 + 4x_3 - 2x_4 = 12$
$2x_1 + 10x_2 - x_3 - 20x_4 = 15$
$x_1 - x_2 + 20x_3 + 4x_4 = -7$
$x_1 + x_2 - 20x_3 - 3x_4 = -5$ [20]

QUESTION 4

Define the100×100 square matrix A and the column vector b by

$$A_{ij} = I_{ij} + \frac{1}{-j^2+2},\ b_i = 1 + \frac{1}{i},\ 1 \leq i,j \leq 100$$

where I_{ij} is the 100×100 identity matrix (i.e. 1 on the main diagonal and 0 everywhere else). Solve $Ax = b$ for x using both the Gauss-Seidel method and the $A\backslash b$ construct. Do not give the whole vector x in your output, but only $x_2,\ x_{50}$ and x_{99}. [20]

QUESTION 5

Find the best straight line $(y = mx + c)$ fit to the data points

$$(x,y) = (0,1),\ (2,0),\ (3,1),\ (3,2),\ (3,1).$$

Produce a graph showing the line, together with the given data points as discrete points. [5]

QUESTION 6

The sales figures for a business are as follows for the first six months of the year:
R40 000, R44 000, R52 000, R64 000, R80 000, R84 000.
The owner believes that the sales curve can be approximated by a quadratic function. Find the best quadratic fit to the data, and use it to estimate the projected sales for the rest of the year. [20]

*textbf QUESTION*7

Find the eigenvalues and eigenvectors of the following matrices, using both *eig* and *power_method* (for the dominant eigenvalue and eigenvector). If the power method fails, discuss why. For those matrices that are diagonalizable, give the diagonalized matrix.

(a)

$$\begin{pmatrix} 2.781344 & -1.921334 & 0.493612 & 1.367198 & -1.014289 \\ 0.015050 & -0.205731 & 0.903377 & 1.780261 & -0.824057 \\ -0.087144 & 0.606003 & 2.977860 & -0.140473 & -0.750938 \\ 0.212440 & -2.477599 & 0.980236 & 4.233562 & -1.207581 \\ -0.136646 & -1.168924 & 0.453692 & 0.915245 & 1.712964 \end{pmatrix}$$

[5]

(b)

$$\begin{pmatrix} -1.54575 & -3.47002 & -1.70112 & -2.58917 \\ -3.28104 & -2.07998 & -1.45597 & -2.75629 \\ 0.55497 & 0.94078 & 2.02863 & 0.46100 \\ 8.94120 & 9.67047 & 4.47796 & 9.09710 \end{pmatrix}$$

[5]

QUESTION 8

Consider the fictional species, and suppose that the population can be divided into three different age groups: babies, juveniles and adults. Let the population in year n in each of these groups be

$$x_{(n)} = \begin{pmatrix} x_{b(n)} \\ x_{j(n)} \\ x_{a(n)} \end{pmatrix}$$

The population changes from one year to the next according to $x_{(n+1)} = Ax_{(n)}$, where the matrix A is

$$A = \begin{pmatrix} 1/2 & 5 & 3 \\ 1/2 & 0 & 0 \\ 0 & 2/3 & 0 \end{pmatrix}$$

In the long term, what will be the relative distribution of the population amongst the age groups?
[15]

Total [100]

APM1513
ASSIGNMENT 03
Linear programming
FIXED CLOSING DATE: 25 September 2023

- The assignment must be answered using Octave (or MATLAB), and for each question you must include your computer code including any .m files used, as well as the output. These should be copied and pasted into a word processing system, and you should produce a single file containing all the answers to the questions in the assignment, which can then be printed out, for hard copy submission, or submitted electronically via *MyUnisa*.
- We **will not accept** hand-written solutions, or anything that does not contain Octave (or MATLAB) code and output.
- In many questions, as well as the computer code and output, you will need to include some form of comment in your answer. This should be in the form of complete sentences that make sense to the reader.
- You should use a fixed space font such as courier for computer code and output, and something else for discussion.
- Question 1 does not carry any marks, but is **compulsory** as it enables us to check that your student number was actually used in an Octave (or MATLAB) session.
- There are 65 marks distributed as shown, and 65 marks = 100%.

QUESTION 1

Enter the following two commands, and copy and paste the output as your answer
> **rand("state",student_number0916);**
> **rand(1)**
where student_number0916 is your student number with "0916" at the end and with "-" removed. For example, if your student number is 123-456-7, you would enter
> **rand("state",12345670916);**
> **rand(1)**

QUESTION 2

Find the minimum value as well as the point at which the minimum occurs of

$$L = -3x_1 - 4x_2 + x_3$$

subject to the constraints

$$\begin{aligned} -x_1 + x_2 + 2x_3 &\leq 5 \\ 2x_1 + x_2 + x_3 &\leq 20 \\ x_1, x_2, x_3 &\geq 0 \end{aligned}$$

[20]

QUESTION 3

Find the minimum value as well as the point at which the minimum occurs of

$$L = -2x_1 - 5x_2 + x_3$$

subject to the constraints

$$\begin{aligned} x_1 + 2x_2 - x_3 &\leq 6 \\ x_2 + 2x_3 &\leq 6 \\ 2x_2 + x_3 &\leq 4 \\ x_1, x_2, x_3 &\geq 0 \end{aligned}$$

[20]

QUESTION 4

Find the minimum value as well as the point at which the minimum occurs of

$$L = -2x_1 - 10x_2 + 27x_3 + 50x_4 + 32x_5$$

subject to the constraints

$$\begin{aligned} x_1 + 2x_2 + x_3 + 1x_4 + 2x_5 &\leq 6 \\ x_2 + 2x_3 + 7x_4 - 3x_5 &\leq 6 \\ 2x_2 + x_3 + 1x_4 - 2x_5 &\leq 4 \\ 6x_1 + x_2 + x_3 + x_5 &\leq 16 \\ -2x_3 + 4x_4 + 9x_5 &\leq 30 \\ x_1, x_2, x_3 &\geq 0 \end{aligned}$$

[25]

Total [65]