

**MODULE HANDBOOK 2020 – 2021**

|  |
| --- |
| **Module Title: Operational Research and Optimisation** **Module Code: AQ052-3-M****Year /Level: Master** **Credits: 3****Co – requisite or pre-requisite module(s): -** **School: School of Mathematics, Actuarial & Quantitative Studies** **Semester: 2** |

**Contents**

|  |  |  |
| --- | --- | --- |
|  | Section | Page |
| 1. | Introduction | 3 |
| 2. | Module Team | 3 |
| 3. | Module Learning Outcomes | 3 |
| 4. | How will I learn on this module? | 3 – 8  |
| 5. | Attendance and Absence | 8  |
| 6. | Learning Resources | 8  |
| 7. | Assessments | 9 |
| 8. | Submission and Feedback | 9 – 10  |
| 9 | Academic Integrity | 10 |
| 10. | Module Descriptor | 10 |
|  |  |  |

|  |
| --- |
| **1.0 Introduction** |

Welcome to **Operational Research and Optimisation**

This module introduces students to the operational research methodologies and their application to real life problems. Emphasis will be on the use of operational research approaches to support decision making in data extensive environment.

|  |
| --- |
| **2.0 Module Team** |

Module Leader: Dr. Ho Ming Kang (ming.kang@staffemail.apu.edu.my)

Module Team –

(a) Norain Alwi (Norain.alwi@staffemail.apu.edu.my)

|  |
| --- |
| **3.0 Module Learning Outcomes** |

Upon successful completion of this module, you will be able to:

|  |  |
| --- | --- |
| CLO 1 | Comprehend the fundamental of operational research models (C2, PLO1).  |
| CLO 2 | Perform the operational research modeling using computer software (A2, PLO6).  |
| CLO 3 | Interpret the output of operational research modeling in solving practical problems in industry (C5, PLO7).  |

|  |
| --- |
| **4.0 How will I learn on this module?** |

In this module you will attend a range of classes as well as studying independently and preparing for assessments. The plan below describes the work you will need to do to be successful in this module.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Week #** | **Weekly learning Outcomes** | **Topic Coverage**  | **Hours** | **In class Learning Activities** | **Independent Learning Activities** |
| 1 | * Students will be able to formulate a problem into a linear programming model.
* Students will be able to solve the linear programming model using computer software.
 | **Linear Programming** * Model formulation
* Graphical method
* Simplex method
* Computer solution
 | 6.5(2L, 1T, 0.5P, 3Ind) | * Provide materials for students to have self-study for their background knowledge.
* Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
 |
| 2 | * Students will be able to solve the model and interpret the sensitivity report including shadow price, range of feasibility and optimality.
* Students will be able to formulate a transportation and assignment problems into a linear programming model.
* Students will be able to use computer software to solve the problems and interpret the results.
 | **Linear Programming** * Sensitivity analysis
* Computer solution

**Transportation model and its variant** * Transportation problem
* Assignment problem
* Computer solution
 | 3.5(0.5P, 3Ind)7(2L, 1T, 4Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Complete the exercises given.
 |
| 3 | * Students will be able to formulate a transshipment problem and solve using computer software
* Students will be able to extend the concepts of transshipment model to solve a shortest path problems using computer software.
* Students will be able to formulate a problem into an integer linear programming model.
* Students will be able to interpret the results.
 | **Transportation model and its variant** * Transshipment model
* Shortest path problem
* Computer solution

**Integer Linear Programming** * Model formulation
* All-integer linear programming
 | 5(2P, 3Ind)4.5(1L, 0.5T, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Discussion to clarify doubts from students about linear programming modeling.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
 |
| 4 | * Students will be able to formulate a problem into a binary integer and mixed integer linear programming model.
* Students will be able to explain the formulation of goal programming model.
* Students will be able to solve the model using computer software and interpret the results.
 | **Integer Linear Programming** * Model formulation
* Binary integer linear programming
* Mixed integer linear programming
* Computer solution

**Goal programming** * Model formulation
* Preemptive goal programming
 | 5.5(1L, 0.5T, 1P, 3Ind)4(1L, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
 |
| 5 | * Students will be able to extend the goal programming model into weighted goal programming model.
* Students will be able to formulate an unconstrained nonlinear model.
* Students will be able to solve the model using computer software and interpret the results.
 | **Goal programming** * Weighted goal programming
* Computer solution

**Nonlinear Programming** * Model formulation
* Unconstrained problem
* Computer solution
 | 4(1L, 1P, 2Ind)4.5(1L, 0.5P, 3Ind)  | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Discussion to clarify doubts from students about goal programming modeling.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
 |
| 6 | * Students will be able to formulate a constrained nonlinear model.
* Students will be able to solve the model using computer software and interpret the results.
* Students will be able to model a network problem.
* Students will be able to apply shortest path algorithm to solve the network using computer software.
 | **Nonlinear Programming** * Model formulation
* Constrained problem
* Computer solution

**Network models** * Model formulation
* Shortest path algorithm
* Computer solution
 | 3.5(1L, 0.5P, 2Ind)5(1L, 1T, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Discussion to clarify doubts from students about nonlinear programming modeling.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Revise on the topic 1 – 5 which will be assessed in Practical Test.
* Practice the questions of Sample Practical Test given.
 |
| 7 | * Students will be able to explain the types of minimum spanning tree algorithms and solve the network problem using appropriate algorithm / method.
* Student will be able to solve the network problem using computer software.
* Students will be able to present a problem using payoff table and decision tree.
* Students will be able to make decision with and without probability given.
 | **Network models** * Model formulation
* Kruskal algorithm
* Boruvka’s algorithm
* Computer solution

**Decision analysis** * Payoff table
* Decision making without probability
* Decision making with probability

  | 4(1L, 1P, 2Ind)4.5(1L, 0.5T, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Provide additional questions on Topic 1 – 5 for students to practice.
* Conduct revision for Practical Test
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Revise the Topic 1 – 5.
* Practice Sample Practical Test and additional questions given.
 |
| 8 | * Students will be able to solve the decision tree using computer software and interpret the results.
* Students will be able to explain the meaning and concepts of a Markov process.
* Students will be able formulate a problem into a Markov process.
 | **Decision analysis** * Decision making with sample information
* Computer solution

**Markov model** * Model formulation
* Steady-state probability
 | 4.5(1L, 1P, 0.5T, 2Ind)4(1L, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Conduct Practical Test (Topic 1 – 5).
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
 |
| 9 | * Students will be able to solve the Markov model using computer software and interpret the results.
* Students will be able to explain the characteristics of a waiting line system.
* Students will be able to explain the characteristics and distribution of a waiting line model.

  | **Markov model** * Model formulation
* Absorbing state
* Computer solution

**Waiting line models** * Markov process – Poisson and Exponential
* Single server waiting line model

  | 5(1L, 1T, 1P, 2Ind)2.5(0.5L, 2Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Give feedback about the performance of Practical Test.
* Hand-out the Project question.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Answer the Project questions.
 |
| 10 | * Students will be able to determine types of waiting line model in a system.
* Students will be able to evaluate the waiting line model in a system using computer software and interpret the results.
* Students will be able to describe Monte Carlo simulation.
 | **Waiting line models** * Multiple server waiting line model
* Operating characteristics
* Computer solution

**Simulation** * Simulation techniques
* Monte Carlo simulation
 | 5.5(1.5L, 1T, 3Ind) 4(1L, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Discussion to clarify doubts from students about the Project.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Answer the Project questions.
 |
| 11 | * Students will be able to apply simulation using computer software and interpret the results.
* Students will be able to use Gantt chart to present a project.
* Students will be able to solve a project scheduling problem with certain activity times.
 | **Simulation** * Applications of simulation in waiting line problem
* Computer solution

**Project scheduling** * Gantt chart
* Project scheduling with certain activity times
 | 6(1L, 1T, 1P, 3Ind)2.5(0.5L, 2Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
* Discussion to clarify doubts from students about the Project.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Answer the Project questions.
 |
| 12 | * Students will be able to use PERT/CPM to solve a project scheduling problem.
* Students will be able to solve the project scheduling problem using computer software and interpret the results.
 | **Project scheduling** * Project scheduling with uncertain activity times
* Computer solution
 | 6.5(1.5L, 1T, 1P, 3Ind) | * Examples discussed with complete solution using computer software.
* Discussion on case studies led by the lecturer on the modeling and its concept.
* Class exercises given to students.
 | * Read the materials and practice the exercises given to enhance the skills in modeling.
* Read up the relevant material in the subject manual.
* Complete the exercises given.
* Submit the Project.
 |

|  |
| --- |
|  |

|  |
| --- |
| **5.0 Attendance and Absence** |

Attendance for all formal teaching is compulsory. On some occasions, for instance illness, your absence may be unavoidable. All absences must be notified to the relevant lecturer or Office immediately. Please refer to your Programme Handbook for contact details. The University needs to satisfy itself that you are engaged in your studies and will monitor your attendance at regular intervals. This is a particular requirement for international students but applies equally to all students. Details of when and how this will be undertaken will be given to you at orientation briefing.

|  |
| --- |
| **6.0 Learning Resources** |

Essential Readings:

1. Anderson, D.R., Sweeney, D.J., Williams, T.A., Camm, J.D., Cochran, J.J. (2018). An Introduction to Management Science: Quantitative Approach, 15th Edition. South-Western College Pub, ISBN: 978-1337406529.

2. Ronald L Rardin (2016). Optimisation in Operations Research (2nd Edition), Pearson. ISBN: 978-0134384559.

3. Sengupta, R.N., Gupta, A., Dutta, J. (2016). Decision Sciences: Theory and Practice, 1st Edition. CRC Press. ISBN: 978-1466564305.

Further Readings:

Cotle, R.W., Thapa, M.N. (2017). LInear and Nonlinear Optimisation, 1st Edition. International Series in Operations Research & Management Science. ISBN: 978-1493970537.

Key Journals: -

Special Requirement (e.g: software, nursery, computer lab, simulation room, etc): Microsoft Excel, R Software

|  |
| --- |
| **7.0 Assessments** |

This module is assessed by:

|  |
| --- |
| **Assessment Summary** |
| **Form of Assessment** | **Description** | **Duration****(hour(s)** | **Hand out Date** | **Hand in Date** | **Marks Allocation** | **CLOs Assessed** |
| **Final Assessment** |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **Continuous Assessment** | Practical Test  | 2 | Week 8 | Week 9 | 40% | CLO1 |
| Project  | - | Week 9 | Week 12 | 60& | CLO2 & CLO3 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

To pass a module, you must attempt every element of assessment and achieve at least 50% in the module overall.

If you fail to pass the module, you will be required to re-sit any assessment components for which you did not pass. *Details on Regulation and Policies are available at* <https://lms2.apiit.edu.my/course/view.php?id=750>

|  |
| --- |
| **8.0 Submission and Feedback** |

**How do I submit my assessments?**

Each module will have a different set of assessments and submission dates/times as stated in Section 7 above. It is your responsibility to be aware of the deadlines and to meet them.

You must submit all pieces of assessment required for each module to Admin Services, or online through APU’s official submission portal for electronic submissions, on or before the submission date for each piece of assessment. Failure to do so may result in failure of the module overall.

Failure to meet a deadline will be treated as a non-submission and a Grade Point 0 will be awarded for that component. The only exceptions to these rules apply where a valid claim for extenuating circumstances can be made and is approved.

There may be occasions when you are unable to submit or undertake a piece of assessment due to circumstances beyond your control. APU has put in place a procedure for dealing with such extenuating circumstances. You can find more information in the Student Guide to Extenuating Circumstances which is available in the Regulations & Policies section on Moodle.

**How do I get feedback on my work?**

You will normally receive feedback on all assessments, other than examinations, within 20 working days following the date of submission.

APU aims to release feedba**c**k within set weeks so that you can have as much of your feedback at once making the process less stressful.

Feedback will vary between modules; however, you will receive feedback via the Coursework Submission and Feedback Form (CSFF) as a minimum. Feedback may also be received by forums, interviews, and individual feedback sessions.

You will also be able to access your results via Moodle.

**How can I give feedback on the module?**

You are welcome to discuss your views with your lecturer on the module at any time. Views may also be expressed through your Programme Leader or via Programme Committee Meetings (PCM). During the course of the module, you will be encouraged to fill in the anonymous evaluation questionnaires to assist the University in its monitoring and planning. Such questionnaires are important for the benefit of your fellow and future students. We would be grateful for your full and prompt co-operation in completing them in a constructive and objective way. You will be able to access the Online Course Appraisal System at: <http://webapps.apiit.edu.my/appraisal/>

Students who do not complete their course appraisal by the stipulated date indicated on their examination schedule (posted on the webspace) could find their results withheld until they complete their course appraisal.

|  |
| --- |
| **9.0 Academic Integrity** |

This module requires that you demonstrate what you have learnt and that you have achieved the learning outcomes of the module. The University requires you to comply with the regulations on academic conduct. Academic misconduct includes but is not restricted to cheating in examinations, making - up data and plagiarism.

Plagiarism is the use of someone else’s work (words, images, tables or ideas etc) without acknowledging the source. This includes materials from the internet as well as library books and the work of another person. Plagiarism is an assessment offence and any individual (who is suspected of plagiarism) will be referred to the University Academic Dishonesty Board. Please refer to <https://lms2.apiit.edu.my/course/view.php?id=750> for further information.

|  |
| --- |
| **10.0 Module Descriptor** |

The module descriptor for this module is available on Moodle