COURSE CONTENT

<table>
<tr><td>Academic Year</td><td>AY2023-24</td><td>Semester</td><td>1 and 2</td></tr>
<tr><td>School/Programme</td><td colspan="3">EEE / Master of Science (CCA)</td></tr>
<tr><td>Course Code</td><td colspan="3">EE6204</td></tr>
<tr><td>Course Title</td><td colspan="3">Systems Analysis</td></tr>
<tr><td>Pre-requisites</td><td colspan="3">Nil</td></tr>
<tr><td>No of AUs</td><td colspan="3">3</td></tr>
<tr><td>Contact Hours</td><td colspan="3">39</td></tr>
<tr><td>Expected Implementation date of new/revised course</td><td colspan="3">AY2023-24 Semester 1</td></tr>
<tr><td>Any cross-listing?
Is course opened to all Postgraduate students (including IGP) or specific program (please indicate)?</td><td colspan="3">
<table>
<tr><td colspan="5">Within EEE</td><td rowspan="2">MEng</td><td rowspan="2">PhD</td><td rowspan="3">Outside EEE
(Please specify)</td></tr>
<tr><td colspan="5">MSc Programmes*</td></tr>
<tr><td>CME</td><td>CCA</td><td>ET</td><td>PE</td><td>SP</td></tr>
<tr><td></td><td>SE</td><td></td><td></td><td>GE</td><td>√</td><td>√</td><td>All Postgraduate research students under CoE and IGP</td></tr>
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* List of MSc programmes
- MSc Communication Engineering (CME) Programme
- MSc Computer Control & Automation (CCA) Programme
- MSc Electronics (ET) Programme
- MSc Power Engineering (PE) Programme
- MSc Signal Processing (SP) Programme
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Course Aims

Optimization techniques are applicable in almost all fields of postgraduate study and wide spectrum of industry and societal applications. This course aims to equip post graduate students with popular and useful optimization techniques, such as Linear Programming, Nonlinear Programming, Random processes, Queuing modelling, and Decision Analysis.

Intended Learning Outcomes (ILO)

By the end of this course, the students should be able to understand specific theories for modelling, analysis and optimization of various practical and popular systems and processes. In particular, students would be able to:

1. Develop linear programming model from description of problems
2. Solve linear programming problems using SIMPLEX method
3. Examine the sensitivity of optimal solution due to change in parameters
4. Develop and solve dual linear programming problems
5. Solve special types of linear programming problems: transportation and assignment
6. Solve unconstrained nonlinear programming problems using numerical methods
7. Solve constrained nonlinear programming problems using Lagrange multiplier methods
8. Model a stochastic process to a discrete time Markov chain
9. Compute different aspects of a discrete time Markov chain: transition probability, sojourn time, steady state probability
10. Model a stochastic process to a continuous time Markov chain
11. Compute different aspects of a continuous time Markov chain: transition rate, sojourn time, steady state probability
12. Study different queuing models: M/M/1, M/M/1/N, M/M/m, M^b/M/1
13. Compute different aspects of a queue: steady state probability, mean number of customers in the queue and system, mean waiting time in the queue and system
14. Derive a decision under certainty: analytic hierarchy process

15. Derive a decision under risk: decision tree, utility function
16. Derive a decision under uncertainty: criterion of pessimism, criterion of optimism, Hurwicz criterion, criterion of regret, Laplace criterion

Course Content

Topic 1 Linear, Dynamic and Integer Programming
Topic 2 Optimization Techniques
Topic 3. Random Processes
Topic 4. Queuing Models
Topic 5. Decision Analysis

Assessment (includes both continuous and summative assessment)

Component	ILO Tested	Weighting	Team/Individual	Assessment Rubrics
1. Final Examination	ILO 1 – ILO 16	60%	Individual	
2. Continuous Assessment 1 (CA1): Quiz	ILO 1 to ILO 5	16%	Individual	
3. Continuous Assessment 2 (CA2): Quiz	ILO 8 to ILO 13	16%	Individual	
4. Continuous Assessment 3 (CA3): Assignment	ILO 14 – ILO 16	8%	Individual	
Total		100%		

Description of Assessment Components:
There will be two quizzes, CA1 to be conducted on week 4-5 and CA2 on week 9-10 to test students' basic understanding of topics covered. There will be take home assignment on week 11-13 to cover topics in decision analysis.
There will be final examination lasting 3 hours in the university exam period to test students' comprehensive understanding of all major topics covered in the whole course.

Formative feedback

Students will receive their continuous assessment results. Feedback on how you solve the questions including mistakes made will also be provided.

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lecture	This subject is highly analytical and systematic in its contents and topics. The lecture allows the students to have a clear logic and methodological understanding. The lectured topics will be well digested with multiple

	Quizzes and assignment.
TEL Video Recording	All the lectures will be recorded and all the slides will be uploaded so students can also learn on the website or review again at home.

Reading and References

Textbook:

1. Taha H. A., Operations Research: an Introduction, 10th Edition, Pearson, 2017.
2. Privault N., Understanding Markov Chains: Examples and Applications, 2nd edition, Springer, 2018.
3. Gross D., Shortle J. F., Thompson J. M. and Harris C. M., Fundamentals of Queueing Theory, 4th edition, Wiley, 2008.

References:

1. Frederick S. Hillier and Gerald J. Lieberman, Introduction to Operations Research, 10th Edition, McGraw Hill, 2015.
2. Viswanadham N. and Narahari Y., Performance Modeling of Automated Manufacturing Systems, Prentice Hall, 1992.
3. Peterson M., An Introduction to Decision Theory, Cambridge University Press, 2009.

Course Policies and Student Responsibilities

(1) General

You are expected to complete all assigned pre-class readings and activities, attend all seminar classes punctually and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for seminar sessions they have missed. You are expected to participate in all seminar discussions and activities.

(2) Absenteeism

Absence from class without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.

If you miss a lecture, you must inform the course instructor via email prior to the start of the class.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these

terms, you should go to the Academic Integrity Intranet Site for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email

Industry Participation

Company Name	Description of involvement (e.g., co-curation of course, speaker or instructor), include no. of course hours if known.	Contact Person	Email
Industry speaker invited can give a talk on the queueing process in manufacturing facility. Just a talk, not lecture.			

Planned Weekly Schedule

Week	Topic	ILO	Readings/ Activities
1 -2	Linear, Dynamic and Integer Programming (6 hours) Linear Programming and Simplex method. Duality and sensitivity analysis. Network flow problems. Transportation and assignment problems. Integer programming. Dynamic programming. Applications to equipment selections and production strategies. CA1: Quiz	ILO 1 to ILO 5	Read the notes for lectures 1 to 3. Work out solutions to the examples in the same lecture notes.
3 - 4	Optimization Techniques (6 hours) Unconstrained optimization: Fibonacci, golden section Newton's and other methods. Optimization with equality and inequality constraints: nonlinear optimization, Kuhn-Tucker conditions, quadratic	ILO 6 to ILO 7	Read notes for lecture 4. Work out solutions to the examples in the lecture 4 notes.

	programming.		
5 - 7	Random Processes (9 hours) Stochastic process. Poisson process. Discrete-time Markov chain. Chapman-Kolmogorov equation. Long-run properties of Markov chain. First passage times. Absorbing states. Continuous time Markov chain. Birth-death process.	ILO 8 to ILO 11	Read lecture notes on random processes. Work out solutions to the examples in the lecture notes.
8 - 9	Queuing Models (6 hours) Basic structure of queuing models. Examples of real queuing systems. The role of the exponential distribution. Queuing models based on the birth-death process, M/M/s model, M/M/s/K model. The application of queuing theory. CA2: Quiz	ILO 12 to ILO 13	Read lecture notes on queuing models. Work out solutions to the examples in the lecture notes.
10 - 13	Decision Analysis (12 hours) Decision making under certainty. Analytic Hierarchy Process. Consistency ratio. Decision making under risk. Decision tree. Utility theory. Attitude towards risk. Decision making under uncertainty. Criterion of pessimism. Criterion of optimism. Hurwicz criterion. Criterion of regret. Laplace criterion. CA3: Assignment	ILO 14 to ILO 16	Read lecture notes on decision analysis. Work out solutions to the examples in the lecture notes.