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School of Science and Computing
+353 (0)51 302037
Eleanor.Reade@setu.ie
www.wit.ie/schools/science_computing

Ollscoil Teicneolaíochta an Oirdheiscirt

South East Technological University

# Module Descriptor

# Network Theory (Computing and Mathematics)

# Network Theory (A13484)

**Short Title:** Network Theory
**Department:** Computing and Mathematics
**Credits:** 5 **Level:** Intermediate

## Description of Module / Aims

The aim of this module is to introduce the fundamental concepts in information theory, and to study common problems that arise in network theory using graphs/network models and neural network concepts.

## Programmes

| | | stage/semester/status |
|---|---|---|
| COMP-0313 | BSc (Hons) in Applied Computing (International) (WD_KACCM_BI) | 3 / 6 / M |
| COMP-0313 | BSc (Hons) in Applied Computing (WD_KACCM_B) | 2 / 4 / E |
| COMP-0313 | BSc (Hons) in Applied Computing (WD_KCOMP_B) | 2 / 4 / E |
| COMP-0313 | BSc (Hons) in Computer Science (WD_KCMSC_B) | 2 / 4 / E |
| COMP-0313 | BSc (Hons) in Software Engineering (WD_KDEVP_BI) | 3 / 6 / M |

## Indicative Content

- Graph and Network Models: transportation and transhipment problems; shortest route; spanning trees; flow models; project networks; application of network models; LP and IP formulation of network decision problems
- Information Theory: information measure and entropy; source coding; Shannon theory and Huffman codes; noisy channel coding theorem; channel codes and linear block codes; cyclic error correcting codes
- Neural networks: introduction to neural networks; McCulloch Pitts neurons; associative memory problem; Hopfield model and Hebbs rule; storage capacity and energy function; stochastic neural networks
- Supervised learning: perceptrons and layered networks; conjugate-gradient methods; performance of multilayer networks

## Learning Outcomes

*On successful completion of this module, a student will be able to:*

1. Formulate decision problems as mathematical programs (both linear and mixed) and perform standard sensitivity analysis.
2. Use mathematical software to solve network based optimisation problems and interpret solutions generated.
3. Assess the fundamental limits of a channel to communicate information reliably using the relevant theorems of Shannon.
4. Construct and simulate a range of basic coding techniques.
5. Demonstrate an understanding of the concepts and techniques of neural networks.
6. Apply neural networks to particular applications, and be able to determine appropriate steps to improve performance.

## Learning and Teaching Methods

- The module is covered through a series of lectures supported by problem solving sessions and some directed independent learning.
- The lectures will develop theory, lead students through worked examples and introduce the context for the module material.
- The practical sessions will utilise existing software network libraries to solve selected problems using concepts covered in lectures.
- Active engagement with frequent practice on examples is strongly encouraged through regular course work consisting of a mixture of practical activities graded from guided to self-directed tasks.

## Learning Modes

| Learning Type | F/T Hours | P/T Hours |
|---|---|---|
| Lecture | 24 | |
| Practical | 24 | |
| Independent Learning | 87 | |

## Assessment Methods

| | Weighting | Outcomes Assessed |
|---|---|---|
| Final Written Examination | 50% | 1,3,4,5 |
| Continuous Assessment | 50% | |
| Assignment | 20% | 1,2 |
| Assignment | 30% | 4,6 |

## Assessment Criteria

*<40%:* Inability to demonstrate knowledge or understanding of the fundamental concepts in network models, information theory and neural networks as outlined in the syllabus content, inability to apply concepts to selected problems.

*40%–49%:* Able to demonstrate a basic understanding of the fundamental concepts in network models, information theory and neural networks as outlined in syllabus content.

*50%–59%:* In addition to above, able to find the complete solution set to basic problems, and in addition, able to supply a reasonable interpretation of generated results.

*60%–69%:* All the above, in addition be able to independently determine appropriate mathematical techniques to analyse applied problems and to express their work with rigour and precision.

*70%–100%:* All the above to an excellent level. Demonstrates an ability to put a solution into a context and assess whether such solutions are meaningful.

## Supplementary Material(s)


- "Fast Artificial Neural Network Library." leenissen.dk.fann/
- "Java Universal Network/Graph Framework." jung.source.net/
- Ahuja, R., T. Magnanti and J. Orlin. *Network flows: Theory, Algorithms and Applications.* NY: Prentice Hall, 1993.
- Heaton, J. *Introduction to Neural Networks in Java.* 2nd. USA: Heaton Research, Inc., 2008.
- Jones, G. and J. Jones. *Information and Coding Theory.* NY: Springer, 2000.


## Requested Resources

- Room Type: Computer Lab