Module Code	EEU44C04 / EEP55C27 / CSU44031 / CS7NS3
Module Name	Next Generation Networks
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Prof. Marco Ruffini and Prof. Nicola Marchetti
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline	On successful completion of this module a student will be able to: 1. Describe the basic characteristics, structure and operation of wired and wireless networks. 2. Identify appropriate architectural models, systems strategies and use cases for a range of modern network concepts. 3. Reason about the challenges and impediments that new, disruptive networking paradigms encounter, as well as their appropriate application. 4. Implement solutions to key challenges in modern network architecture, e.g., scalability, cost effectiveness and energy efficiency. 5. Implement solutions to key challenges in the wireless space e.g., mobility, interference, energy consumption in relation to UN SDG no. 7 Affordable and Clean Energy. 6. Evaluate the performance of queues and develop network traffic models. 7. Assess the operation of medium access protocols in contemporary wireless standards for local and wide area networks, and Internet of Things, and discuss co-existence between different types of systems.
Module Content	This module aims to provide both a theoretical and practical understanding of modern and next generation networking and systems concepts, principles, practices and technologies. Contemporary and emerging wired and wireless network systems are targeted. Students will be exposed to a variety of system platforms, architectures, protocols, models and algorithms, with a strong focus on key design principles and practices e.g. performance, scalability, mobility, virtualization. The module also aims to highlight some of the relevant ongoing research and innovation in the space taking place within Ireland and internationally. Specific topics addressed in this module include:

[1] TEP Glossary

1. Optical Transmission systems

a. Propagation in fibre, dispersion and nonlinearities

b. Optical transmitters, modulation, direct detection and coherent receivers

c. Link design, BER curves, optical amplification, OSNR, GOSNR, physical impairments and Margins, WDM and flexgrid

2. Contemporary and emerging wireless network architecture and systems:

a. Wireless channel impairments and mitigation techniques, overview of wireless networks

b. Mobile architectures: LTE, LTE-A, 5G New Radio, 6G

c. Wireless local area networks: IEEE 802.11, small cell deployments, mmWave, Terahertz

3. Convergence of mobile and fixed architectures: backhaul, fronthaul, midhaul and protocol convergence

4. Quantum communications networks and protocols

a. Introduction to quantum systems (black body radiation, interferometry, uncertainty principle)

b. Concept of qubit (superposition, measurement, Bloch sphere, Entanglement and Bell states, No cloning theorem, quantum circuits)

c. Quantum Key Distribution (cryptography, concept of measurement basis, BB84, BBM92, practical issues)

d. Quantum networks (Teleportation, entanglement swapping, entanglement distribution networks)

5. Traffic modelling

a. Introduction to queuing theory: M/M/1 queue, other M/M queues, M/G/1 queue

b. Network traffic models: Poisson arrival process, self-similarity

6. Recent trends in wireless networking

a. Role of AI/ML in wireless networks

b. Internet of Things, Machine-type communication

c. Vehicular communications

d. Other trends in 6G: autonomous networks, integrated communications and sensing, intelligent reflectors, digital twin

Teaching and Learning Methods

Teaching and learning will be based on lectures and tutorials.

Assessment Details[2]
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Examination	2 Hour Written Exam	LO1, LO2, LO3, LO4, LO5, LO6, LO7	70%	N/A
In-Class Quiz	Multiple Choice Quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	6
In-Class Quiz	Multiple Choice Quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	12

Reassessment Requirements

Examination (2 hours, 100%)

Contact Hours and Indicative Student Workload[2]

Contact Hours (scheduled hours per student over full module), broken down by:	**33 hours**
lecture	26 hours
tutorial or seminar	4 hours
Invited talks from industry	3 hours
other	0 hours
Independent study (outside scheduled contact hours), broken down by:	**80 hours**
preparation for classes and review of material (including preparation for examination, if applicable)	76 hours
completion of assessments (including examination, if applicable)	4 hours
Total Hours	**113 hours**

Recommended Reading List

- Wireless Networking, Understanding Internetworking Challenges, J. L. Burbank, J. Andrusenko, J.S. Everett, W.T.M. Kasch, Wiley, 2013.
- Computer Networks and Systems: Queuing Theory and Performance Evaluation, 3rd edition, T.G. Robertazzi, Springer, 2000.

[2] TEP Guidelines on Workload and Assessment

	• Optical Networks: A Practical Perspective, 3rd Edition, R. Ramaswami, K. N. Sivarajan, G. H. Sasaki, Morgan Kaufmann, 2010 • Quantum Optics, an introduction. Mark Fox. Oxford Series.
Module Pre-requisite	**Other/alternative non-module prerequisites:** General knowledge of networking protocols and transmission.
Module Co-requisite	CSU33D03 Computer Networks or CSU33032 Advanced Computer Networks
Module Website	Material available on Blackboard
Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.	Co-delivered by the School of Engineering & the School of Computer Science and Statistics
Module Approval Date	
Approved by	Prof. Naomi Harte
Academic Start Year	September 2026
Academic Year of Date	2026-27