<table>
<tr><td>1.</td><td>Name of Course</td><td colspan="5">Networks and Routing</td></tr>
<tr><td>2.</td><td>Course Code</td><td colspan="5">GNET5023</td></tr>
<tr><td>3.</td><td>Name(s) of academic staff</td><td colspan="5"></td></tr>
<tr><td>4.</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="5"><u>Core Module</u>
Remarkable advances in traditional telephony have been observed. The underlying telecommunication system has changed from analog to digital and has incorporated the latest advances in optical technologies and, more recently, voice over IP. Throughout these revolutionary changes, routing has continued to play a significant role. Modern computer and telecommunication networks are able to react to randomly fluctuating demands and failures by rerouting traffic and by reallocating resources. This is done so well that, in many respects, large scale networks appear as coherent, almost intelligent, organisms. The design and control of such networks require an understanding of a variety of fundamental issues.</td></tr>
<tr><td>5.</td><td>Semester and Year offered</td><td colspan="5">Semester 1 / Year 1</td></tr>
<tr><td rowspan="3">6.</td><td>Total Student Learning Time (SLT)</td><td colspan="4">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical
O= Others</td><td>L</td><td>T</td><td>P</td><td>O</td><td rowspan="2">Independent study=84 hours

Total =126</td></tr>
<tr><td>28</td><td>14</td><td>/</td><td>84</td></tr>
<tr><td>7.</td><td>Credit Value</td><td colspan="5">3
28 Hours of Lecture
14 Hours of Tutorial</td></tr>
<tr><td>8.</td><td>Prerequisite (if any)</td><td colspan="5">None</td></tr>
<tr><td>9.</td><td colspan="6">Objectives:
Studying the network routing algorithms, protocols, and architectures, is very timely. The course provides an in-depth understanding of routing in a wide variety of types of networks. It includes extensive coverage of the evolution of routing over time. Particularly appealing is its in-depth coverage across a spectrum of algorithmic, technical, experiential, and practical issues.</td></tr>
<tr><td>10.</td><td colspan="6">Learning outcomes:
By the end of the subject, students should be able to:
Understand the Networking and Network Routing concepts
Recognize Routing Algorithms, specifically the Shortest Path and Widest Path
Recognize the Framework and Principles related to Routing Protocols
Understand the traffic engineering approaches
Understand the basic background of IP routing and protocols for Internet that falls into the distance vector protocol family
Understand the Open Shortest Path First (OSPF) and the integrated Intermediate system to intermediate system (IS-IS) protocols
Demonstrate an in-depth understanding of routing in the public switched telephone network (PSTN)
Understand the issue of providing seamless voice service (and/or multimedia services) between an IP and PSTN, and demonstrate an understanding of routing in this hybrid IP-PSTN environment</td></tr>
</table>

11.	**Transferable Skills:** - Literature and data searching skills - Independent study and self learning skills - Technical writing and presentation skills - Oral/Written Communication skills - Critical thinking and problem solving skills - Time and Self-management skills - Teamwork skills - Independent research skills - Analysis and decision-making skills - IT skills
12.	**Teaching-learning and assessment strategy** A variety of teaching and learning strategies are used throughout the course, including: • Classroom lessons. Lectures and Power Point presentations • Tutorials • Hands-on Laboratory Sessions • brainstorming • Lecturer-led problem-solving sessions • Solving assigned problems in groups and individually • collaborative and co-operative learning; • Independent study. Assessment strategies include the following: • Performance Assessment (Project, participation, Assigned exercises) • Lecturer Observation • Quizzes, tests, and examinations
13.	**Synopsis:** The course covers the basic foundations of routing from algorithms to protocols, along with network flow modelling. Furthermore, the IP network routing is discussed from standardized protocols for both intra- and inter-domain routing, to IP traffic engineering and Internet routing architectures. The PSTN routing is also covered, from hierarchical routing to dynamic routing, and from addressing to traffic engineering, including the role of signalling in routing, along with the impact of number portability in routing, in addition to VoIP Routing.
14.	**Mode of Delivery:** • Classroom lessons. Lectures and Presentations • Tutorial sessions: Practice exercises • Hands-on Laboratory Sessions
15.	**Assessment Methods and Types:** The assessment for this course will be based on the following: **Coursework** **40%** • Midterm test **10%** • Assignment **10%** • Project **20%** **Final Examination** **60%** **Assessment** **100%**

16. **Mapping of the course/module to the Programme Aims**

A1	A2	A3	A4	A5	A6	A7
5	4	3	4	3	3	2

17. **Mapping of the course/module to the Programme Learning Outcomes**

LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8
2	3	3	4	3	3	3	3

18. **Content outline of the course/module and the SLT per topic**

	Details	SLT				
		L	T	P	O	Total
Topic 1	**Networking and Network Routing: An Introduction** • Addressing and Internet Service: An Overview • Network Routing: An Overview • IP Addressing • On Architectures • Service Architecture • Protocol Stack Architecture • Router Architecture • Network Topology Architecture • Network Management Architecture • Public Switched Telephone Network • Communication Technologies • Standards Committees • Last Two Bits	2	1	0	6	9
Topic 2	**Routing Algorithms: Shortest Path andWidest Path** • Bellman–Ford Algorithm and the Distance Vector Approach • Dijkstra's Algorithm • Comparison of the Bellman–Ford Algorithm and Dijkstra's Algorithm • Shortest Path Computation with Candidate Path Caching • Widest Path Computation with Candidate Path Caching • Widest Path Algorithm • K-Shortest Paths Algorithm	2	1	0	6	9
Topic 3	**Routing Protocols: Framework and Principles** • Routing Protocol, Routing Algorithm, and Routing Table • Routing Information Representation and Protocol Messages • Distance Vector Routing Protocol • Link State Routing Protocol • Path Vector Routing Protocol • Link Cost	2	1	0	6	9

	Topic 4	**Network Flow Modeling** • Single-Commodity Network Flow • Multicommodity Network Flow: Three-Node Example • Multicommodity Network Flow Problem: General Formulation • Multicommodity Network Flow Problem: Non-Splittable Flow	2	1	**0**	**6**	**9**
	Topic 5	**IP Routing and Distance Vector Protocol Family** • Routers, Networks, and Routing Information: Some Basics • Static Routes • Routing Information Protocol, Version 1 (RIPv1) • Routing Information Protocol, Version 2 (RIPv2) • Interior Gateway Routing Protocol (IGRP) • Enhanced Interior Gateway Routing Protocol (EIGRP) • Route Redistribution	2	1	**0**	**6**	**9**
	Topic 6	**Open Shortest Path First (OSPF) and Integrated IS-IS** • From a Protocol Family to an Instance of a Protocol • OSPF: Protocol Features • OSPF Packet Format • Examples of Router LSAs and Network LSAs • Integrated IS-IS • Similarities and Differences Between IS-IS and OSPF	2	1	**0**	**6**	**9**
	Topic 7	**IP Traffic Engineering** • Traffic, Stochasticity, Delay, and Utilization • Applications' View • Traffic Engineering: An Architectural Framework • Traffic Engineering: A Four-Node Illustration • Link Weight Determination Problem: Preliminary Discussion • Duality of the MCNF Problem • Illustration of LinkWeight Determination Through Duality • Link Weight Determination: Large Networks	2	1	**0**	**6**	**9**

	Topic 8	**Border Gateway Protocol (BGP)** • BGP: A Brief Overview • BGP: Basic Terminology • BGP Operations • BGP Configuration Initialization • Two Faces of BGP: External BGP and Internal BGP • Path Attributes • BGP Decision Process • Internal BGP Scalability • Route Flap Dampening • BGP Additional Features • Finite State Machine of a BGP Connection • Protocol Message Format	2	1	**0**	**6**	**9**
	Topic 9	**Internet Routing Architectures** • Internet Routing Evolution • Addressing and Routing: Illustrations • Current Architectural View of the Internet • Allocation of IP Prefixes and AS Number • Policy-Based Routing • Point of Presence • Traffic Engineering Implications • Internet Routing Instability	2	1	**0**	**6**	**9**
	Topic 10	**Hierarchical and Dynamic Call Routing in the Telephone Network** • Hierarchical Routing • The Road to Dynamic Routing • Dynamic Nonhierarchical Routing • Dynamically Controlled Routing • Dynamic Alternate Routing • Real-Time Network Routing • Classification of Dynamic Call Routing Schemes • Maximum Allowable Residual Capacity Routing • Dynamic Routing and Its Relation to Other Routing	2	1	**0**	**6**	**9**

	Topic 11	**Traffic Engineering in the Voice Telephone Network** • Why Traffic Engineering? • Traffic Load and Blocking • Grade-of-Service and Trunk Occupancy • Centi-Call Seconds and Determining Offered Load • Economic CCS Method • Network Controls for Traffic Engineering • State-Dependent Call Routing • Analysis of Dynamic Routing	2	1	**0**	**6**	**9**
	Topic 12	**SS7: Signaling Network for Telephony** • Why SS7? • SS7 Network Topology • Routing in the SS7 Network • Point Codes: Addressing in SS7 • Point Code Usage • SS7 Protocol Stack • SS7 Network Management • ISUP and Call Processing • ISUP Messages and Trunk Management • ISUP Messages and Dynamic Call Routing • Transaction Services • SS7 Link Traffic Engineering	2	1	**0**	**6**	**9**
	Topic 13	**Public Switched Telephone Network: Architecture and Routing** • Global Telephone Addressing • Setting Up a Basic Telephone Call and Its Steps • Digit Analysis versus Translation • Routing Decision for a Dialed Call • Call Routing: Single National Provider Environment • Call Routing: Multiple Long-Distance Provider Case • Multiple-Provider Environment: Multiple Local Exchange Carriers • Routing Decision at an Intermediate TDM Switch • Number Portability • Nongeographic or Toll-Free Number Portability • Fixed/Mobile Number Portability • Multiple-Provider Environment with Local Number Portability	2	1	**0**	**6**	**9**

	Topic 14	**VoIP Routing: Interoperability Through IP and PSTN** • PSTN Call Routing Using the Internet • PSTN Call Routing: Managed IP Approach • IP-PSTN Interworking for VoIP • IP Multimedia Subsystem • Multiple Heterogeneous Providers Environment • All-IP Environment of VoIP Services • Addressing Revisited	2	1	**0**	**6**	**9**
	Total SLT		**126**				
19.	**Main references supporting the course:** 1. Deepankar Medhi and Karthikeyan Ramasamy, **"Network Routing: Algorithms, Protocols, and Architectures"**. Morgan Kaufmann, 2007						
	Additional references supporting the course: 1. Rich Seifert, James Edwards. "The All-New Switch Book: The Complete Guide to LAN Switching Technology", Wiley, 2008. 2. Radia Perlman. "Interconnections: Bridges, Routers, Switches, and Internetworking Protocols". Addison-Wesley Professional, 1999. 3. Charles M. Kozierok. "The TCP/IP Guide: A Comprehensive, Illustrated Internet Protocols Reference", No Starch Press, 2005. 4. Douglas E. Comer. "Internetworking with TCP/IP, Vol 1 (5th Edition)", Prentice Hall, 2005.						
20.	**Other additional information** All materials will be available to the students online.						