

Course Title	Network System Design	Course No	old COM506			
Department/ Specialization	Computer Science and Engineering	Credits	L	T	P	C
			3	1	0	4
Faculty proposing the course	Noor Mahammad Sk	Status	Core <input type="checkbox"/>	Elective	■	
Offered for	M.Tech, PhD - CSE, ECE	Type	New <input type="checkbox"/>	Revision	■	
To take effect from		Submitted for approval	— Senate			
Prerequisite	Computer Networks, Computer Organization, Operating System					
Learning Objectives	The objective of this course is to give in-depth treatment on fundamental topics like encoding, error control and switching from hardware perspective. More focus will be given on switching internals, data plane and control plane of switches & routers. The course will also look at routing and congestion control algorithms at hardware level. Concepts like VLAN, VPN, DTN and software defined network will also be introduced.					
Learning Outcomes	Functions of the network systems. Operating principles of network interface cards. Hardware and software mechanism of the Network Interface Card. Computing perspective of the network function implementation. Complexity of Network Processor and its design schemes.					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	<p>Introduction and overview: Network systems and Internet, Applications vs Infrastructure, basic terminology and example systems, review of protocols and packet formats (4 hrs+1T).</p> <p>Network Interface Card hardware: functionality, optimizations for high speed, onboard address recognition, packet buffering, DMA, operation and data chaining (4hrs+1T).</p> <p>Packet Processing: Algorithms - Bridge, lookup and hashing, IP- Fragmentation, Reassembly and forwarding algorithms, TCP – connection Recognition and Splicing algorithms; Data structures, functions –error detection and correction, packet classification, queueing and packet discard, scheduling and timing (6 hrs+3T).</p> <p>Protocol Software on a conventional Processor: Fast packet processing, software interrupts and priorities, software for layered protocols (3hrs + 2T).</p> <p>Hardware Architecture for Protocol Processing: Network system architecture, data rate, packet rate and software router feasibility, overcoming single CPU bottleneck, fine and course-grain parallelism, special purpose/AISC coprocessors, NICs with onboard processing and Data pipeline (6 hrs + 2T).</p> <p>Classification and Forwarding: Classification - Packet, software implementation and optimization, hardware implementation and optimization, hybrid hardware/software classification. Forwarding – flow forwarding connection and connectionless network; Second generation network systems, embedded processors in second generation systems, classification and forwarding chips (4hrs + 2T).</p> <p>Switching Fabrics: Concepts, synchronous and asynchronous fabrics, taxonomy, crossbar architectures, queueing, sharing data paths, shared bus, medium, memory architectures, multistage fabrics, Banyan architectures – scalability, commercial technologies (6hrs).</p> <p>Network Processors Design: third generation network system, scalability with parallelism and pipelining, costs and benefits of network processors, network processor functionality, Ingress and Egress processing, parallel and distributed architecture, The architectural role of network processors, Network processor design and software emulation (4hrs + 2T).</p> <p>Network Processor Architectures and Scalability: Architectural characteristics, Architecture, Packet flow and clock rates, software architecture, assigning functionality to the processor hierarchy and scaling, scaling – faster processors, increasing the number of processors and their types, memory hierarchy, size and bandwidth, adding caches, CAM, limitation on scale, software scalability(4hrs). Case study of commercial network processors (1hr).</p>					
Essential Reading	1. Douglas E Comer, Network System Design using Network Processors, Prentice Hall Publisher, First Edition, 2005, ISBN: 978-0131417922.					
Supplementary Reading	1. Ran Giladi, Network Processors: Architecture, Programming, and Implementation (System on Silicon), Morgan Kaufmann Publishers, First Edition, 2008, ISBN: 978-0123708915. 2. Gregory J Pottie and William J Kaiser, Principles of Embedded Networked Systems Design, Cambridge University Press, First Edition, 2009, ISBN: 9780511541049.					