BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJASTHAN)
INSTRUCTION DIVISION
FIRST SEMESTER 2011-2012
<u>**Course Handout (Part II)**</u>

Aug 03, 2011

In addition to part-I (General handout for all courses appended to the timetable) this portion gives further specific details regarding the course:

Course Number & Title　　　: **IS C462 Network Programming**
Instructor In-Charge　　　　: **HARI BABU K**
Course Website　　　　　　**: http://csis/faculty/khari/NetProg111**

1. Scope and Objective of the Course

This course is intended for software engineers involved in developing, maintaining and supporting distributed and network applications in UNIX environment. The course teaches starting from the basics of computer networks to designing and implementing network servers such as web, mail servers etc. Other well known network programming paradigms like RPC are also studied. Various well known protocols like TELNET, HTTP, FTP, SMTP, NFS etc are discussed to demonstrate the network programming concepts. Course structure also involves interesting assignments and labs to strengthen the concepts.

2. Text Book

T1. W. R. Stevens,UNIX Network Programming, Vol I, Networking APIs: Sockets and XTI, Pearson Education, 3rd Edition.

T2. W.R.Stevens, UNIX Network Programming, Interprocess Communication, Vol II Pearson Education, 2nd Edition.

3. Reference Books

R1. Understanding TCP/IP: A Clear and Comprehensive Guide by Libor Dostálek and Alena Kabelová Packt Publishing © 2006 (http://library.books24x7.com/toc.aspx?bookid=25603)

R2. W.R. Stevens, Advanced Programming in the UNIX Environment, Pearson Education, 2008.

R3. The Definitive Guide to Linux Network Programming by Keir Davis, John Turner and Nathan Yocom (http://www.books24x7.com/toc.asp?bookid=9771)

R4. IPv6 Socket API Extensions: Programmer's Guide by Qing Li, Tatuya Jinmei and Keiichi Shima, Morgan Kaufmann Publishers © 2009 (http://library.books24x7.com/toc.aspx?bookid=32311)

4. Course Plan:

Lec#	Topics	Reference
1	**Overview of Computer Networks and Network programming:** OSI reference model; TCP/IP protocol suite; network API and kernel;	T1: Ch1
2-4	**Process Management and Working With Signals In Unix:** process definition, environment through environment variables, command-line arguments; process memory layout; process creation-fork(), vfork(); process control - wait(), waitpid(); program loading-exec() family; process termination-exit(), _exit(); non-local goto-setjmp(), longjmp(); signals- signal disposition, reliable and unreliable ways of signals, creation, pending and delivery stages; signal sets-blocking, unblocking; useful signals-SIGINT, SIGKILL, SIGTERM, SIGALRM, alarm(), pause()	R2:Ch 7, 8, 10
5-8	**Inter Process Communication:** types of IPC-pipes, FIFOs, Message Queues, Semaphores, Shared memory; pipes-characteristics, creating a pipe, writing and reading from a pipe, popen(), synchronization, process pipe-lining, co-processes; FIFO- named pipe, characteristics, contrast with pipes, opening, reading and writing, non-blocking option; Message Queues-characteristics, contrast with pipes/fifos, concept of key space, identifier, ftok(), msgget(), msgsnd(), msgrcv(), msgctl(); semaphores-	T2: Ch 4, 6, 11, 14 R2:Ch 15

	characteristics, semget(),semop(),semctl(), semadj variable usage; shared memory- characteristics, fastest IPC, shmget(),shmat(),shmdt(),shmctl()	
9-10	**Workings of TCP, UDP Layers:** characteristics of IP layer- ICMP characteristics, its utility; multiplexing/demultiplexing network messages- concept of port numbers, reserved range by IANA; UDP characteristics-unreliable, preserves message boundaries; TCP characteristics-connection oriented, reliable, byte-stream, full-duplex; TCP segments-flags; TCP flow control-sliding window; TCP connection establishment-SYN/ACK sequence; TCP connection termination-FIN/ACK sequence; TCP buffers; TCP connection state diagram- state names, TIME_WAIT purpose	R1:Ch 5, 9 , 10 T1:Ch 2
11-12	**Sockets and Sockets API:** what is a socket, socket pair, socket descriptor, socket address structure, end point addressing, TCP client and server API	T1: Ch 3,4
13-14	**TCP Client-Server Programming:** Echo protocol, Writing a TCP client, Writing TCP server; Designing a custom protocol; Implementing a protocol; Designing servers- iterative vs concurrent, SIGCHLD handling, SIGPIPE signal, slow-system call interruptions; handling exceptional conditions such as peer crash in client and server. Case Studies: TELNET, HTTP	T1:Ch 5 R3:Ch 4,6,7 R1:Ch12, 14
15-16	**I/O Multiplexing and its Applications in Network Programming:** different IO models, monitoring multiple descriptors using select(), fd set, conditions for readability, writability, exception conditions; TCP client with select(); TCP server with select(), application of select in batch mode clients, need for shutdown system call	T1: Ch6
17-18	**UDP Client-Server Programming:** writing a UDP client and server- recvfrom(),sendto();handling exceptional conditions; connected UDP sockets; Flow control; TCP vs UDP; Adding reliability to UDP application, RTT measurement; writing concurrent UDP servers. Case Study: TFTP	T1:Ch 8,22
19-20	**Domain Name Conversion:** DNS Protocol, gethostbyname(), gethostbyaddr(), getservbyname(),getservbyport(), getaddrinfo()	T1: Ch 11 R1: Ch 11
21-22	**Daemon Processes:** writing them, and study well known daemons such as *inetd* super server: Need for daemon process; daemonizing a process-process groups, sessions, setsid(), controlling terminal; *inetd* super server- purpose, design, how to integrate new services into *inetd*; syslogd daemon	T1: Ch 13
23-26	**Advanced Socket Programming:** socket options- SO_ERROR, SO_KEEPALIVE, SO_LINGER, SO_REUSEADDR, TCP_NODELAY; Timeouts- alarm(), select(), socket options; Advanced I/O functions- send(), recv(), readv(), writev(), sendmsg(), recvmsg(), Unix Domain C/S programming-socket addressing, socketpair(), stream sockets, datagram sockets; Passing descriptors and credentials among unrelated processes, Non-blocking I/O: Connect	T1: Ch 7, 14, 15, 16
27-28	**Usage of Threads in Client-Server Programming:** overview of threads- thread vs process, creation of threads, thread join, mutexes, condition variables, client and server using threads	T1: Ch 26

29-30	**Broadcasting and Multicasting Techniques:** Broadcasting vs Unicasting, Broadcast addresses; Multicasting- multicasting vs broadcasting, Multicast addresses, Multicasting on LAN, Multicasting on WAN, Advantages of Source Specific Multicast, API to join a group, to send and receive messages to a multicast groups	T1: Ch 21, 22
31-33	**Accessing IP Layer Packets and Data-link Layer Packets:** Raw sockets-purpose, input, output, IP_HDRINCL option; applications-ping, trace route, ICMP message daemon; datalink access- capabilities, interfaces-BPF, DLPI, SOCK_PACKET, libpcap, libnet;	T1: Ch 28, 29
34-35	**Remote Procedure Calls :** socket programming vs RPC; SUN RPC model; stubs and skeletons; call semantics; port-mapper; XDR; overview of XML-RPC;	T2: Ch 16 + Class notes
36-37	**Compare and Contrast Different Models for Concurrent Server Design:** Multiplexing, Forking, Multithreading, Preforking, Prethreading, Preforking and Prethreading; Preforking Models; Prethreading Models; Case Study: Apache Web Server	R3: Ch 5 T1: Ch 30
38	**Developing Clients and Servers Using IPv6:** socket creation, IPv6 socket address structure, TCP server and UDP server using IPv6, address name conversion functions for IPv6, IPv4 and Ipv6 interoperability	R4: Ch 1, 2 T1: Ch 12
39-40	**Developing Secure Network Applications:** Securing network communication – tunneling, PKI, OpenSSL; Authentication – PAM, public key authentication; Common security problems: Buffer Overflows.	R3: Ch 10, 11, 12

5. Evaluation Scheme:

Component	Duration	Weightage (%)	Date, Time & Venue	Remarks
Test I	50 min	15		Closed Book
Test II	150 min	20		Online Open Book
Labs	60 min	15		Take Home
Assignments	-	15		Take Home
Comprehensive Examination	3 hours	35		Partly open

6. Notices:

All notices shall be displayed only on IPC notice Board.

7. Malpractices in assignments:

While coding assignments/lab exercises you are not allowed to share source code but discussions are allowed with other groups. Any copying detected among groups/individuals will result in awarding ZERO/-ve marks to all involved groups/individuals.

8. Make-up Policy:

No makeup will be given for Labs and Assignment components. For tests, however, make-up will be granted strictly on prior permission and on justifiable grounds only.

9. Chamber Consultation Hours:

To be announced in the class.

Instructor-in-charge
IS C462