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PES University, Bengaluru
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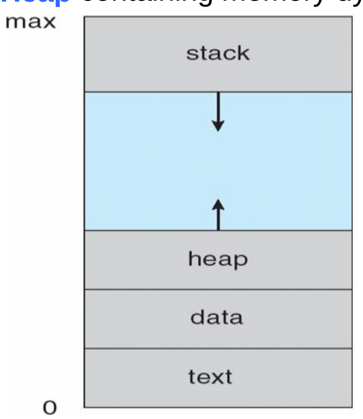
MAY 2022: END SEMESTER ASSESSMENT (ESA) B TECH - MINOR

UE20CS254/19CS254/18CS302 – OPERATING SYSTEM

Time: 3 Hrs | Answer All Questions | Max Marks: 100

1	a)	What do you mean by a process? Whether the process and program are the same? Justify	3
		Process – a program in execution; process execution must progress in sequential fashion. Program is ***passive*** entity stored on disk (**executable file**), process is ***active.*** Program becomes process when executable file loaded into memory.	
	b)	Explain the structure of a process with a neat diagram	5
		The program code, also called **text section-**Includes current activity including **program counter**, processor registers **Stack** containing temporary data-Function parameters, return addresses, local variables **Data section** containing global variables **Heap** containing memory dynamically allocated during run time 	1+4
	c)	Draw and explain the process state transition	6

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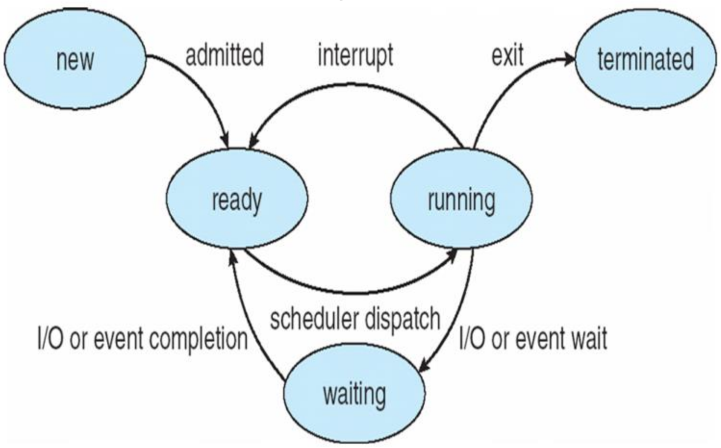
As a process executes, it changes **state**

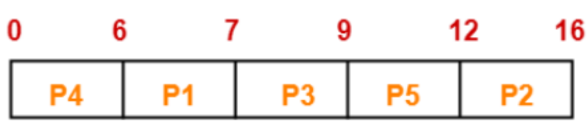
- **New**: The process is being created
- **Running**: Instructions are being executed
- **Waiting**: The process is waiting for some event to occur
- **Ready**: The process is waiting to be assigned to a processor
- **Terminated**: The process has finished execution



Consider the set of 5 processes whose arrival time and burst time are given below-. 6

Sl. No	Process ID	Arrival Time	Burst Time
1	P1	3	1
2	P2	1	4
3	P3	4	2
4	P4	0	6
5	P5	2	3

If the CPU scheduling policy is SJF non-preemptive, calculate the average waiting time and average turnaround time.



Gantt Chart

Average Turn Around time = (4 + 15 + 5 + 6 + 10) / 5 = 40 / 5 = 8 unit
Average waiting time = (3 + 11 + 3 + 0 + 7) / 5 = 24 / 5 = 4.8 unit

2 a) What are two models of inter process communication? 2

- Two models of IPC
  - **Shared memory**
  - **Message passing**

b) Explain Ordinary and Named pipes with an example 6

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		Ordinary Pipes allow communication in standard producer-consumer style Producer writes to one end (the **write-end** of the pipe) Consumer reads from the other end (the **read-end** of the pipe) Ordinary pipes are therefore unidirectional Require parent-child relationship between communicating processes Windows calls these **anonymous pipes** Used by the shell; not used very often by application programs-Main limitation is processes need to be related A FIFO special file (a named pipe) is similar to a pipe, except that it is accessed as part of the filesystem. It can be opened by multiple processes for reading or writing. When processes are exchanging data via the FIFO, the kernel passes all data internally without writing it to the filesystem. echo "hello" >> pipe1 FIFO is a full duplex, meaning the first process can communicate with the second process and vice versa at the same time. Message Queues − Communication between two or more processes with full duplex capacity. … Semaphores − Semaphores are meant for synchronizing access to multiple processes.	
	c)	Differentiate any two key points between threads and process and list the attributes that are shared among threads	6

		Process • Will by default not share memory • Most file descriptors not shared • Don't share filesystem context • Don't share signal handling **Thread** • Will by default share memory • Will share file descriptors • Will share filesystem context • Will share signal handling **Attributes shared among threads** • process ID and parent process ID;process group ID and session ID; • controlling terminal; • process credentials (user and group Ids);open file descriptors; • record locks created using fcntl();signal dispositions; • file system–related information: umask, cwd and root directory; • resource limits;CPU time consumed (as returned by times()); • resources consumed (as returned by getrusage()); nice value (set by setpriority() and nice()).	
	d)	Enumerate and explain the key solution techniques for critical section problem	6
		Mutual Exclusion - If process $\boldsymbol{P_i}$ is executing in its critical section, then no other processes can be executing in their critical sections **Progress** - If no process is executing in its critical section and there exist some processes that wish to enter their critical section, then the selection of the processes that will enter the critical section next cannot be postponed indefinitely **Bounded Waiting** - A bound must exist on the number of times that other processes are allowed to enter their critical sections after a process has made a request to enter its critical section and before that request is granted • Assume that each process executes at a nonzero speed • No assumption concerning **relative speed** of the ***n*** processes	
3	a)	Consider a 32-bit logical address space as on modern computers with page size of 4 KB. Then what is the number of page table entries? If each entry is 4 bytes, then what would be the size of page table in MB?	4

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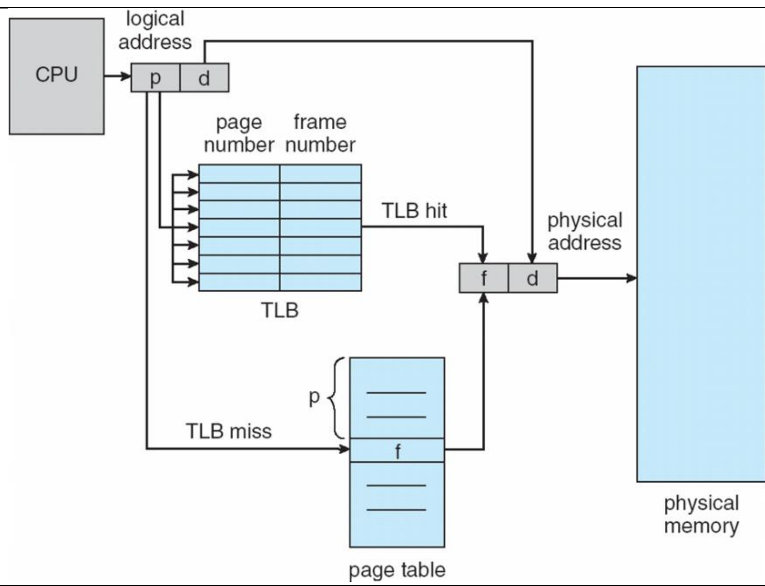
		• Page table would have 1 million entries (2^{32} / 2^{12}) • 4 MB of physical memory for page table alone	
	b)	What do you mean by logical address? What are the components of a logical address? Explain	4
		Logical Address is generated by CPU while a program is running. The logical address is virtual address as it does not exist physically, therefore, it is also known as Virtual Address. This address is used as a reference to access the physical memory location by CPU. The hardware device called Memory-Management Unit is used for mapping logical address to its corresponding physical address. • Address generated by CPU is divided into: ○ **Page number** (*p*) – used as an index into a **page table** which contains base address of each page in physical memory-m ○ **Page offset** (*d*) – combined with base address to define the physical memory address that is sent to the memory unit-n The logical address space is 2^m and page size 2^n	
	c)	Draw and explain the paging hardware with Translation Look aside Buffer	6
			
	d)	Explain external and internal fragmentation in paging	6
		Internal Fragmentation: Paging can leave a free partition of the memory, leading to memory with allocated unused spaces. This is precisely how internal fragmentation occurs in memory. External fragmentation happens when there's a sufficient quantity of area within the memory to satisfy the memory request of a method. However, the process's memory request cannot be fulfilled because the memory offered is in a non-contiguous manner. Whether you apply a first-fit or best-fit memory allocation strategy it'll cause external fragmentation.	
4	a)	What do you mean by a file and filesystem? Where does the file system reside? Give any two examples for file system	6

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File:

collection of related information

Data cannot to be written to disk unless they are in files

Data can be Numeric, alphabetic, alphanumeric, binary

is a sequence of bits, bytes, lines, or records, the meaning of which is defined by the file's creator and user

File system

is a method and data structure that the operating system uses to control how data is stored and retrieved

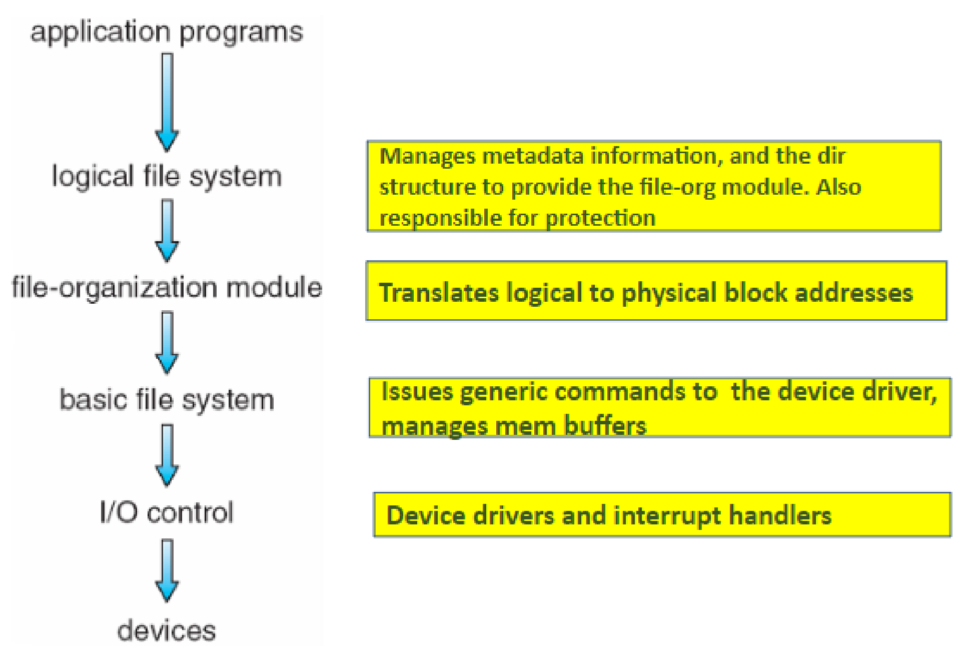
resides on secondary storage (disks)

Provided user interface to storage, mapping logical to physical

Provides efficient and convenient access to disk by allowing data to be stored, located retrieved easily

Examples: NTFS, FAT32

b)	Explain the file system layers and its functionality with a pictorial representation	6



c)	Enumerate the disk space allocation methods used in implementing the file system and explain any two of them in detail with a diagram.	8

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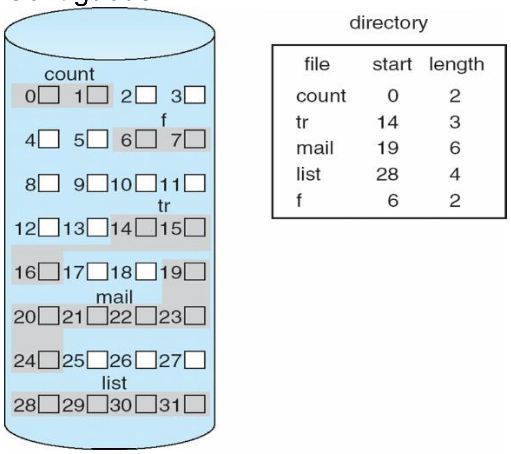
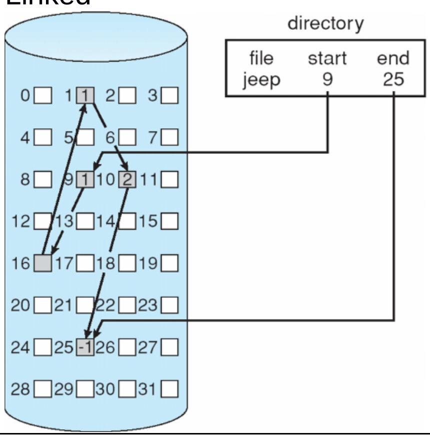
Allocation methods-
Contiguous, Extent-based, Linked, Indexed
Contiguous



Linked



5	a)	Disk scheduling is done by operating systems to schedule I/O requests arriving for the disk. Consider a disk queue with requests for I/O to blocks on cylinders 98, 183, 41, 122, 14, 124, 65, 67. The head is initially at cylinder number 53. The cylinders are numbered from 0 to 199. What is the total head movement (in number of cylinders) incurred while servicing these requests, if FCFS disk scheduling is used?	4

Total head movements incurred while servicing these requests

= (98 – 53) + (183 – 98) + (183 – 41) + (122 – 41) + (122 – 14) + (124 – 14) + (124 – 65) + (67 – 65)

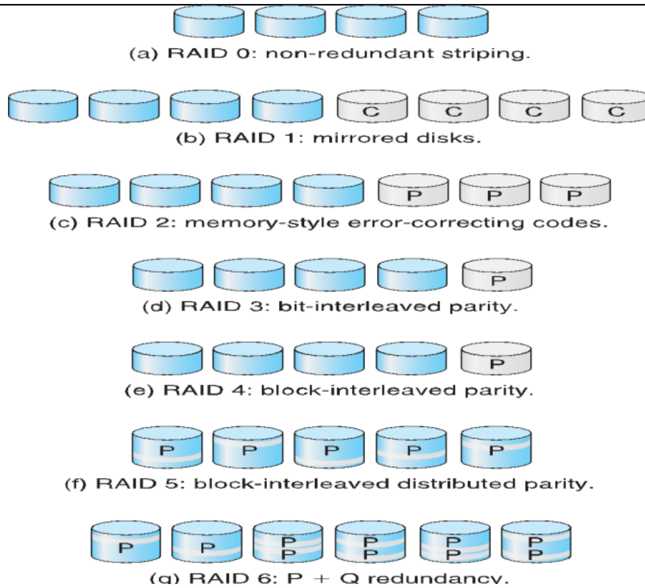
= 45 + 85 + 142 + 81 + 108 + 110 + 59 + 2

= 632

	b)	What is access matrix? Explain how access matrix could be used for protection	6

		View protection abstractly as a matrix (access matrix)
		● Rows represent domains
		● Columns represent objects
		● Access(i, j) is the set of operations that a process
		executing in Domain i
		can invoke on Object j
		• If a process in Domain D_i tries to do “op” on object O_j, then “op” must be in the access matrix
		• User who creates object can define access column for that object
		• Can be expanded to dynamic protection
		  • Operations to add, delete access rights
		  • Special access rights:
		    4 *owner of O_i*
		    4 *copy op from O_i to O_j (denoted by “*”)*
		    4 *control – D_i can modify D_j access rights*
		    4 *transfer – switch from domain D_i to D_j*
		  • *Copy* and *Owner* applicable to an object
		  • *Control* applicable to domain object	

	c)	Explain three different levels/schemes of RAID that helps in enhancing the performance and improving the reliability of the storage system	6



- **RAID level 0** refers to disk arrays with striping at the level of blocks
    - No redundancy (such as mirroring or parity bits)
    - lots of disks means low Mean Time To Failure (MTTF)

RAID level 1 refers to disk mirroring.
- A complete file is stored on a single disk
- A second disk contains an exact copy of the file
- Provides complete redundancy of data
- Read performance can be improved
- file data can be read in parallel
- Write performance suffers
- must write the data out twice
- Most expensive RAID implementation

requires twice as much storage space

RAID level 2 is also known as memory-style error correcting code (ECC) organization.
- Stripes data across disks similar to Level-0
    - difference is data is **bit** interleaved instead of **block** interleaved
    - For ex, the first bit of each byte can be stored in disk 1, the second bit in disk 2, and so on until the eighth bit is stored in disk 8; the error-correction bits are stored in further disks.
- Uses ECC to monitor correctness of information on disk

RAID level 3, or bit-interleaved parity organization;
- One big problem with Level-2 is the number of extra disks needed to detect which disk had an error
- Modern disks can already determine if there is an error
    - using ECC codes with each sector
- So just need to include a parity disk
    - if a sector is bad, the disk itself tells us, and use the parity disk to correct it
- Transfer rate for reading or writing a single block is faster than RAID level 1.
- But supports fewer I/Os per second, since every disk has to participate in every I/O request.

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		• Has performance problem due to the expense of computing and writing the parity.	
	d)	What are the principles of protection that can be used in the design of a computer system?	4
		Principle of least privilege Fine-grained management more complex, more overhead, but more protective	