INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	OPERATING SYSTEMS					
Course Code	ACS007					
Programme	B.Tech					
Semester	IV	CSE	IT			
Course Type	Core					
Regulation	IARE - R16					
Course Structure	**Theory**			**Practical**		
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**	
	3	1	4	3	2	
Chief Coordinator	Dr. Chukka Santhaiah, Professor					
Course Faculty	Dr. D Kishore Babu, Professor Mr. N V Krishna Rao, Assistant Professor Mr. M Rakesh, Assistant Professor					

I. COURSE OVERVIEW:

This course provides a comprehensive introduction to operating system design concepts, data structures and algorithms. The course is designed to provide in-depth critique on the problems of resource management and scheduling, concurrency and synchronization, memory management, file management, peripheral management, protection and security. This course is intended to discuss the topics in a general setting not tied to any one particular operating system. Throughout the course, the study of practical aspects that pertain to the most popular operating systems such as Unix/Linux and Windows are considered as case studies

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACS002	II	Data Structures	4
UG	ACS004	III	Computer Organization and Architecture	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Operating Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignment
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1	Assignment
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Seminar
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.	1	Seminar
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	-	-
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the fundamental principles of the operating system, its services and functionalities.
II	Illustrate the concepts of processes, inter-process communication, synchronization and scheduling.
III	Understand different types of memory management viz. virtual memory, paging and segmentation.
IV	Identify the reasons for deadlock and understand the techniques for deadlock detection, prevention and recovery.
V	Understand the need of protection and security mechanisms in computer systems.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CACS007.01	CLO 1	Describe the structure of operating system and basic architectural components involved in operating system design.	PO 1, PO 2	2
CACS007.02	CLO 2	Describe how the computing resources are managed by the operating system.	PO 1, PO 4	2
CACS007.03	CLO 3	Understand the objectives and functions of modern operating systems.	PO 3	2
CACS007.04	CLO 4	Analyze and design the applications to run in parallel either using process or thread models of different operating system	PO 1	3
CACS007.05	CLO 5	Understand and analyze implementation of virtual memory	PO 2	2
CACS007.06	CLO 6	Understand the various resource management techniques for timesharing and distributed systems.	PO 3	2
CACS007.07	CLO 7	Describe the mutual exclusion, deadlock detection in operating system	PO 3	2
CACS007.08	CLO 8	Describe the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems, such a priority and performance comparison	PO 2, PO 4	1
CACS007.09	CLO 9	Understand the difference between a process and a thread	PO 1	3
CACS007.10	CLO 10	Explain the state diagram that describes the states and state transitions during the whole lifetime of a process; likewise, interpret such a state transition diagram	PO 1, PO 3	2
CACS007.11	CLO 11	Identify the mapping between virtual memory address into a physical address	PO 2, PO 4	1
CACS007.12	CLO 12	Explain how a shared memory area can be implemented using virtual memory addresses in different processes	PO 5	1
CACS007.13	CLO 13	Identify the need of memory management in operating systems and understand the limits of fixed memory allocation schemes	PO 3	1
CACS007.14	CLO 14	Understand the fragmentation in dynamic memory allocation, and identify dynamic allocation approaches	PO 1, PO 5	2
CACS007.15	CLO 15	Understand how program memory addresses relate to physical memory addresses, memory management in base-limit machines, and swapping	PO 1, PO 2	2
CACS007.16	CLO 16	Understand the mechanisms adopted for file distribution in applications	PO 2	2
CACS007.17	CLO 17	Describe different Mass storage structure and I/O systems	PO 2, PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CACS007.18	CLO 18	Understand issues related to file system interface and implementation, disk management	PO 2, PO 3	1
CACS007.19	CLO 19	Identify the mechanisms adopted for file sharing in distributed applications	PO 1, PO 5	1
CACS007.20	CLO 20	Understand the concepts of Storage Management, disk management and disk scheduling	PO 1, PO 3	2
CACS007.21	CLO 21	Understand the concept of deadlock in operating systems and how they can be implemented in multiprogramming system	PO 2	2
CACS007.22	CLO 22	Identify how deadlock can occur and know how it can be prevented or avoided	PO 1, PO 3	1
CACS007.23	CLO 23	Describe the protection and security aspects of operating systems	PO 5	1
CACS007.24	CLO 24	Understand types of security risks in operating system and the role of operating system in establishing security	PO 1, PO 3	1
CACS007.25	CLO 25	Identify different protection and security mechanisms in operating system	PO 1, PO 2	2

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	2											1		
CLO 2	3			1									1		
CLO 3			2												
CLO 4	3												1		
CLO 5		2													
CLO 6			2										1		
CLO 7			2										1		
CLO 8		1		1											
CLO 9	3												1		
CLO 10	3		1										1		
CLO 11		2		1											
CLO 12					1								1		

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 13			1												
CLO 14	3				1								1		
CLO 15	2	2													
CLO 16	2														
CLO 17		2		1									1		
CLO 18		2	1												
CLO 19	2				1								1		
CLO 20	3		2										1		
CLO 21		2													
CLO 22	2		1										1		
CLO 23					1										
CLO 24	2		1										1		
CLO 25	3	2											1		

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XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1,PO 2, PO 3, PO 4, PO5	SEE Exams	PO 1,PO 2, PO 3, PO 4, PO5	Assignments	PO 2, PO 3	Seminars	PO 4, PO 5
Laboratory Practices	PO 1	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	INTRODUCTION
Operating systems objectives and functions: Computer system architecture, operating systems structure, operating systems operations; Evolution of operating systems: Simple batch, multi programmed, time shared, personal computer, parallel distributed systems, real time systems, special purpose systems, operating system services, user operating systems interface; Systems calls: Types of systems calls, system programs, protection and security, operating system design and implementation, operating systems structure, virtual machines	

Unit-II	PROCESS AND CPU SCHEDULING, PROCESS COORDINATION
Process concepts: The process, process state, process control block, threads; Process scheduling: Scheduling queues, schedulers, context switch, preemptive scheduling, dispatcher, scheduling criteria, scheduling algorithms, multiple processor scheduling; Real time scheduling; Thread scheduling; Case studies Linux windows; Process synchronization, the critical section problem; Peterson's solution, synchronization hardware, semaphores and classic problems of synchronization, monitors.	
Unit-III	**MEMORY MANAGEMENT AND VIRTUAL MEMORY**
Logical and physical address space: Swapping, contiguous memory allocation, paging, structure of page table. Segmentation: Segmentation with paging, virtual memory, demand paging; Performance of demand paging: Page replacement, page replacement algorithms, allocation of frames, thrashing.	
Unit-IV	**FILE SYSTEM INTERFACE, MASS-STORAGE STRUCTURE**
The concept of a file, access methods, directory structure, file system mounting, file sharing, protection, file system structure, file system implementation, allocation methods, free space management, directory implementation, efficiency and performance; Overview of mass storage structure: Disk structure, disk attachment, disk scheduling, disk management, swap space management; Dynamic memory allocation: Basic concepts; Library functions.	
Unit-V	**DEADLOCKS, PROTECTION**
System model: Deadlock characterization, methods of handling deadlocks, deadlock prevention, dead lock avoidance, dead lock detection and recovery form deadlock system protection, goals of protection, principles of protection, domain of protection, access matrix, implementation of access matrix, access control, revocation of access rights, capability based systems, language based protection.	
Text Books:	
1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Principles", Wiley StudentEdition, 8th Edition, 2010.. 2. William Stallings, "Operating System- Internals and Design Principles", Pearson Education, 6th Edition, 2002.	
Reference Books:	
1. Andrew S Tanenbaum, "Modern Operating Systems", PHI, 3rd Edition, 2007. 2. D. M. Dhamdhere, "Operating Systems a Concept based Approach", Tata McGraw-Hill, 2nd Edition, 2006	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1 - 2	Computer system architecture, operating systems structure, operating systems operations.	CLO 1	T2: 2.1 T1: 1.1 - 1.5
3 - 4	Evolution of operating systems: Simple batch, multi programmed, time shared, personal computer, parallel distributed systems, real time systems, special purpose systems.	CLO 6	T2: 2.2
5 - 6	Operating system services, user operating systems interface. Systems calls: Types of systems calls, system programs.	CLO 2	T1: 2.1 - 2.5
7 - 8	Protection and security, operating system design and implementation, operating systems structure, virtual machines.	CLO 5	T1: 2.6 - 2.8
9 - 10	The process, process state, process control block, threads.	CLO 10	T1: 3.1 -3.4 T2: 3.1 -3.4
11 - 14	Process scheduling: Scheduling queues, schedulers, context switch, preemptive scheduling, dispatcher, scheduling criteria, scheduling algorithms, multiple processor scheduling.	CLO 8	T1: 5.2 - 5.3
15	Real time scheduling; Thread scheduling.	CLO 8	T1: 5.4 -5.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			T2:10.1-10.2
16	Case studies - Linux, Windows;	CLO 10	T1:5.6,21.4 T2: 8.3 -8.5
17 - 19	Process synchronization, the critical section problem, Peterson's solution, synchronization hardware.	CLO 7	T1: 6.1 - 6.4
20 - 21	Semaphores and classic problems of synchronization, monitors.	CLO 7	T1: 6.5 -6.7 T2: 6.7 -6.8, 6.10
22 - 24	Swapping, contiguous memory allocation, paging, structure of page table, Segmentation with paging.	CLO 11	T1: 8.1 - 8.3
25 - 26	Virtual memory, demand paging, performance of demand paging.	CLO 13	T1: 8.4 -8.6 T1: 9.1 -9.2
27 - 29	Page replacement: Page replacement algorithms, allocation of frames, thrashing.	CLO 15	T1: 9.4 - 9.6
30- 31	The concept of a file, access methods, directory structure.	CLO 18	T1:10.1-10.3
32 - 35	File system mounting, file sharing, protection, file system structure, file system implementation.	CLO 18	T1:10.4-10.6 T1:11.1-11.2
36 - 38	Allocation methods, free space management, directory implementation, efficiency and performance.	CLO 19	T1: 11.3- 11.6
39 - 40	Overview of mass storage structure: Disk structure, disk attachment, disk scheduling, disk management, swap space management.	CLO 20	T1:12.1 - 12.6
41 - 42	Dynamic memory allocation: Basic concepts; Library functions.	CLO 19	T1:12.7 - 12.8
43 - 45	Deadlock characterization, methods of handling deadlocks.	CLO 21	T1: 7.1 - 7.2
46 - 50	Deadlock prevention, dead lock avoidance, dead lock detection and recovery form deadlock system protection.	CLO 22	T1: 7.3 - 7.7
51 - 52	Goals of protection, principles of protection, domain of protection.	CLO 23	T1:14.1 - 14.3
53 - 55	Access matrix, implementation of access matrix, access control, revocation of access rights.	CLO 25	T1:14.4 - 14.7
56 - 58	Capability based systems, language based protection.	CLO 25	T1:14.8 - 14.9

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S no	Description	Proposed actions	Relevance with pos	Relevance with psos
1	Interrupts, Exceptions, and System Calls.	Assignments	PO 2, PO 3	PSO 1
2	Multicore Programming, Multithreading Models	Seminars / Guest Lectures / NPTEL	PO 2, PO 3	PSO 1
3	Free Space Management, I/O Systems	Seminars / NPTEL	PO 1, PO 3	PSO 1

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