Program Name   : Computer Engineering Program Group / Diploma in Artificial Intelligence and Machine Learning / Diploma in Computer Hardware & Maintenance / Diploma in Electronics and Computer Engineering / Diploma in Cloud Computing and Big Data

Program Code   : CO/CM/IF/CW/AN/HA/TE/BD

Semester   : Fifth

Course Title   : Operating System

Course Code   : 22516

1.   RATIONALE

An Operating System is basically a system program that controls the execution of application programs and acts as an interface between applications and the computer hardware. It manages the computer system resources to be used in an efficient manner. This course enables to learn internal functioning of operating system and will help in identifying appropriate Operating System for given applications/task. This course is also a prerequisite for the group of courses included in 'Cloud Infrastructure Maintenance' Elective group

2.   COMPETENCY

The aim of this course is to help the students to attain the following industry identified competency through various teaching learning experiences:

- **Manage operations of Operating System.**

3.   COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:
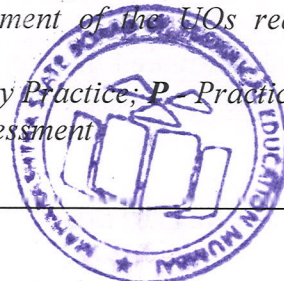
a. Install operating system and configure it.
b. Use operating system tools to perform various functions.
c. Execute process commands for performing process management operations.
d. Apply scheduling algorithms to calculate turnaround time and average waiting time.
e. Calculate efficiency of different memory management techniques.
f. Apply file management techniques.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Paper Hrs.	Theory						Practical					
					ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** – Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment

5.   COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.
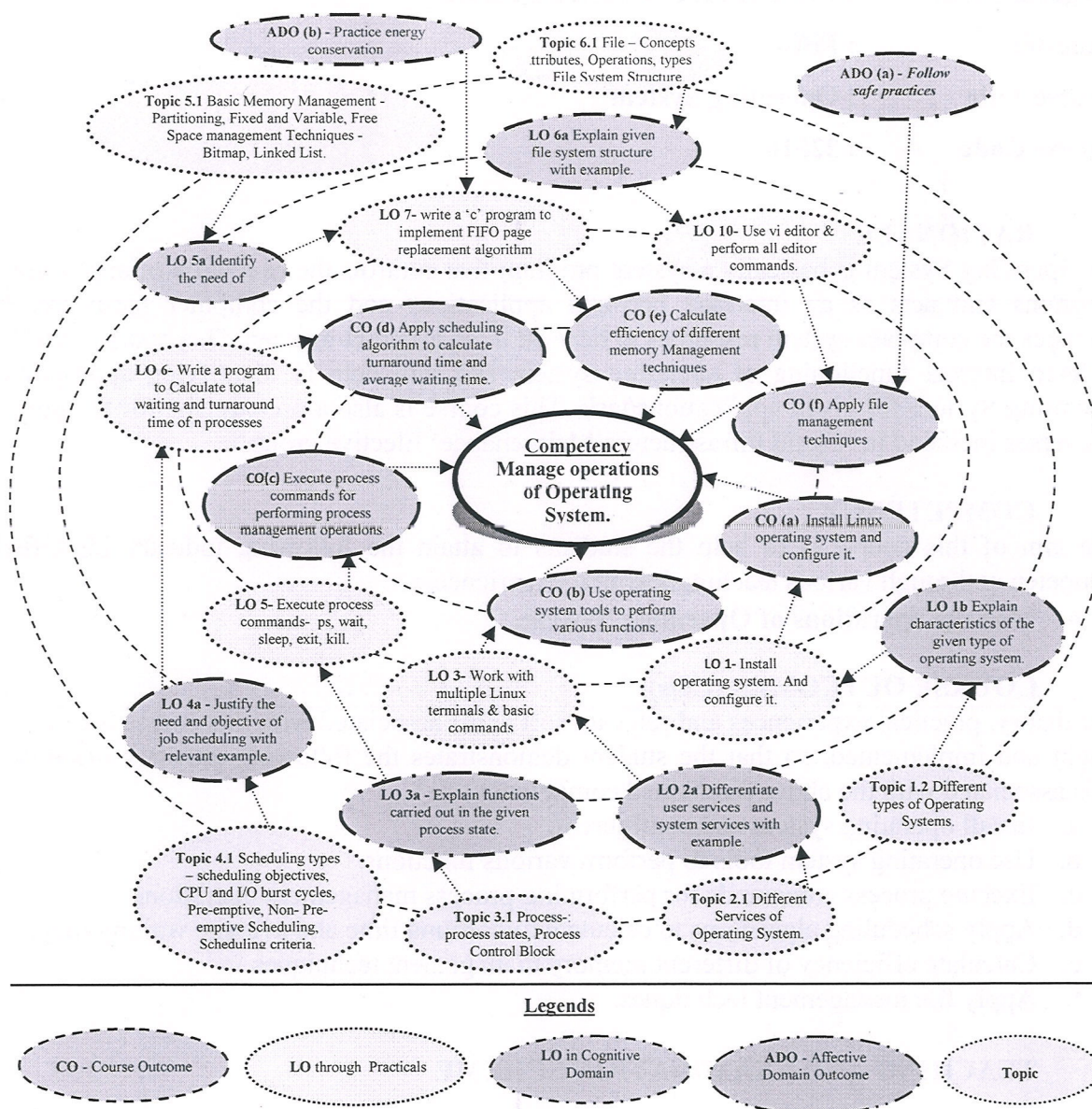

Figure 1 - Course Map

6.   SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:
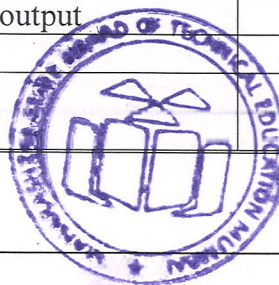
Sr. No.	Practical Outcomes (PrOs	Unit No.	Approx. Hrs. Required
1.	Install and configure Linux (or alike) operating system.	I	02*
2.	Execute general purpose commands date, time, cal, clear, banner	I	02*

Sr. No.	Practical Outcomes (PrOs	Unit No.	Approx. Hrs. Required
	tty, script, man.		
3.	Work with multiple linux terminals and basic commands: who, who am I, login, passwd, su, pwd.	II	02*
4.	a) Use Operating services(Editor, GUI, File handling.) b) Run commands to start, stop, and restart the specified service in Linux.	II	02*
5.	Execute process commands- ps, wait, sleep, exit, kill.	III	02*
6.	Write a program to calculate total waiting and turnaround time of n processes with First Come First Serve CPU scheduling algorithm.	IV	02
7.	Write a 'C' program to implement FIFO page replacement algorithm.	V	02
8.	Execute file and directory manipulation commands – ls, rm, mv, cp, join, split, cat (file saving and redirection operator), head, tail, touch,	VI	02*
9.	Execute file and directory manipulation commands – diff, comm., pr, chmod, mkdir, rmdir, cd, pwd, dir, cmp. (Use wild card character).	VI	02*
10.	Execute text processing tr, wc, cut, paste, spell, sort, grep, more.	VI	02*
11.	Use vi editor and perform all editor commands.	VI	04*
12.	Write and execute Shell Script by using following Control statements features- "if" statement	VI	02*
13.	Write and execute Shell Script by using following Control statements features- "for" statement, exit, break, continue	VI	02*
14.	Write Shell script to find out whether - Given file exists?	VI	02
15.	Write Shell script to find out whether - File has read, write, and execute permissions?	VI	02*
	Total		**32**

Note

i. In the above listed example wherever **Linux** as operating system is mentioned, it could be replaced with other alike operating systems such as **Ubuntu, CentOs** or any other OS.

ii. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Application Level' of Bloom's Taxonomy' as generally required by the industry.

iii. The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Installation/configuration of operating system	25
b.	Correctness of Executing various commands	25
c.	Writing and executing programs to get desired output	20
d.	Debugging the program	15
e.	Submit journal report in time	15
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	Computer system (Any computer system with basic configuration)	All
2	Linux or alike operating system such as Ubuntu, CentOS or any other.	

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of Operating System	1a. Explain the functioning of given component of OS. 1b. Explain characteristics of the given type of operating system. 1c. Identify type of operating system suitable for the given type of application. 1d. Execute command on command line for the given task.	1.1 Operating System – Concept, Components of operating system, operations of OS: Program Management, Resource management, Security and protection. Views of OS: User view, System View 1.2 Different Types of Operating systems- Batch operating system, Multi Programmed, Time Shared OS, Multiprocessor Systems, Distributed Systems, Real time systems. Mobile OS (Android,iOS). 1.3 Command line based OS – DOS, UNIX GUI based OS –WINDOWS, LINUX.
Unit– II Services and Componen	2a. Start, stop, and restart the given service in Linux. 2b. Explain use of the given System call of specified OS.	2.1 Different Services of Operating System. 2.2 System Calls- Concept, types of system calls 2.3 OS Components: - Process Management, Main Memory

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ts of **Operating System**	2c. Explain process the OS follows in managing the given resource. 2d. Explain use of the given operating system tool.	Management, File Management, I/O System management, Secondary storage management. 2.4 Use of operating system tools- user management, security policy, device management, performance monitor, task scheduler
Unit– III Process Management	3a. Explain functions carried out in the given process state. 3b. Describe the function of the given component of process stack in PCB. 3c. Explain characteristics of the given multithreading model. 3d. Describe method of executing the given process command with example.	3.1 Process-: process states, Process Control Block (PCB). 3.2 Process Scheduling- Scheduling Queues, Schedulers, Context switch. 3.3 Inter-process communication (IPC): Introduction, shared memory system and message passing system. 3.4 Threads - Benefits, users and kernel threads, Multithreading Models - Many to One, One to One, Many to Many. 3.5 Execute process commands- like ps, wait, sleep, exit, kill
Unit-IV CPU Scheduling and Algorithms	4a. Justify the need and objective of given job scheduling criteria with relevant example. 4b. Explain with example the procedure of allocating CPU to the given process using the specified OS. 4c. Calculate turnaround time and average waiting time of the given scheduling algorithm. 4d. Explain functioning of the given necessary condition leading to deadlock.	4.1 Scheduling types – scheduling Objectives, CPU and I/O burst cycles, Pre-emptive, Non- Pre-emptive Scheduling, Scheduling criteria. 4.2 Types of Scheduling algorithms - First come first served (FCFS), Shortest Job First (SJF), Shortest Remaining Time(SRTN), Round Robin (RR) Priority scheduling, multilevel queue scheduling. 4.3 Deadlock - System Models, Necessary Conditions leading to Deadlocks, Deadlock Handling - Preventions, avoidance.
Unit –V Memory Management	5a. Describe the working of specified memory management function. 5b. Explain characteristic of the given memory management techniques. 5c. Write algorithm for the given page replacement technique. 5d. Calculate Page fault for the given page reference string.	5.1 Basic Memory Management - Partitioning, Fixed and Variable, Free Space management Techniques - Bitmap, Linked List. 5.2 Virtual Memory – Introduction to Paging, Segmentation, Fragmentation, and Page fault. 5.3 Page Replacement Algorithms: FIFO, LRU, Optimal.
Unit-VI File Management	6a. Explain structure of the given file system with example. 6b. Describe mechanism of the given file access method. 6c. Explain procedure to create and access directories and assign the given files access	6.1 File – Concepts, Attributes, Operations, types and File System Structure. 6.2 Access Methods – Sequential, Direct, Swapping, File Allocation Methods- Contiguous, Linked, Indexed. 6.3 Directory structure – Single level, two levels, tree-structured directory, Disk

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	permissions. 6d. Explain features of the given Raid level structure of hard disk.	Organization and disk Structure-Physical structure, Logical structure, Raid structure of disk, raid level 0 to 6.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9.   SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Overview of Operating System	06	02	02	04	08
II	Services and Components of Operating System	06	02	04	04	10
III	Process Management	10	02	04	08	14
IV	CPU Scheduling and Algorithms	10	02	04	08	14
V	Memory Management	10	02	04	08	14
VI	File Management	06	02	04	04	10
	Total	**48**	**12**	**22**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
<u>*Note*</u>*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10.   SUGGESTED STUDENT ACTIVITIES
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:
   a. Prepare journal of practicals.
   b. Undertake micro-projects.

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)
These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:
   a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
   b. *'L' in item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
   c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
   d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

12.   SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three.*

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Create a report depicting features of different types of Operating systems- Batch operating system, Multi Programmed, Time Shared, Multiprocessor Systems, , Real time systems. Mobile OS with example.
b. Make a comparative statement to calculate page fault for given page reference string by using different page replacement algorithms.
c. Prepare help guide using shell script for all the major Linux commands.
d. Make a comparative chart to calculate total waiting and turnaround time of n processes with different CPU scheduling algorithm.
     Any other micro-projects suggested by subject faculty on similar line.
     (Use features of 'C' or shell scripts to develop above listed applications)

13.   SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Operating System Concepts	Silberschatz, Galvin	John Wiley and Sons, Ninth Edition, 2015, ISBN: 978-51-265-5427-0
2	Operating System	Godbole, Achyut S.	Tata McGraw Hill Education, 2015, ISBN: 9780070591134
3	Operating Systems: Internals and Design Principles	Stallings ,William	Pearsons, 8 edition 2015 ISBN: 978-0133805918
4	Unix Concept and Programming	Das, Sumitabha	McGraw Hill education, 2015, ISBN: 978-0070635463
5	Operating System	Dhamdhere, Dhanjay M.	McGraw Hill, 2015 ISBN MC 978-1-25-900558-9
6	Operating System	Dr. Rajendra Kawale	Devraj Publications,Mumbai ISBN 978-81-935551-1-4

14.   SOFTWARE/LEARNING WEBSITES

a) www.cs.wisc.edu/~ bart/537 lecture notes-University of Wisconsin Madison.

b) www.cs.kent.edu/osf o3/notes/index.html- Vilinius Gediminas Technical University

c) http://www.howstuffworks.com/operating-system1.htm

d) www.computerhope.com/jargon/o/os.htm

e) www.en.wikipedia.org/wiki/Operating system

f) https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/12_MassStorage.html