

Program Name : Computer Engineering Program Group
Program Code : CO/CM/IF/CW
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:

- Install operating system and configure it.
- Use operating system tools to perform various functions.
- Execute process commands for performing process management operations.
- Apply scheduling algorithms to calculate turnaround time and average waiting time.
- Calculate efficiency of different memory management techniques.
- Apply file management techniques.

4. TEACHING AND EXAMINATION SCHEME

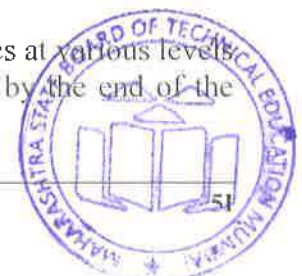
Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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.

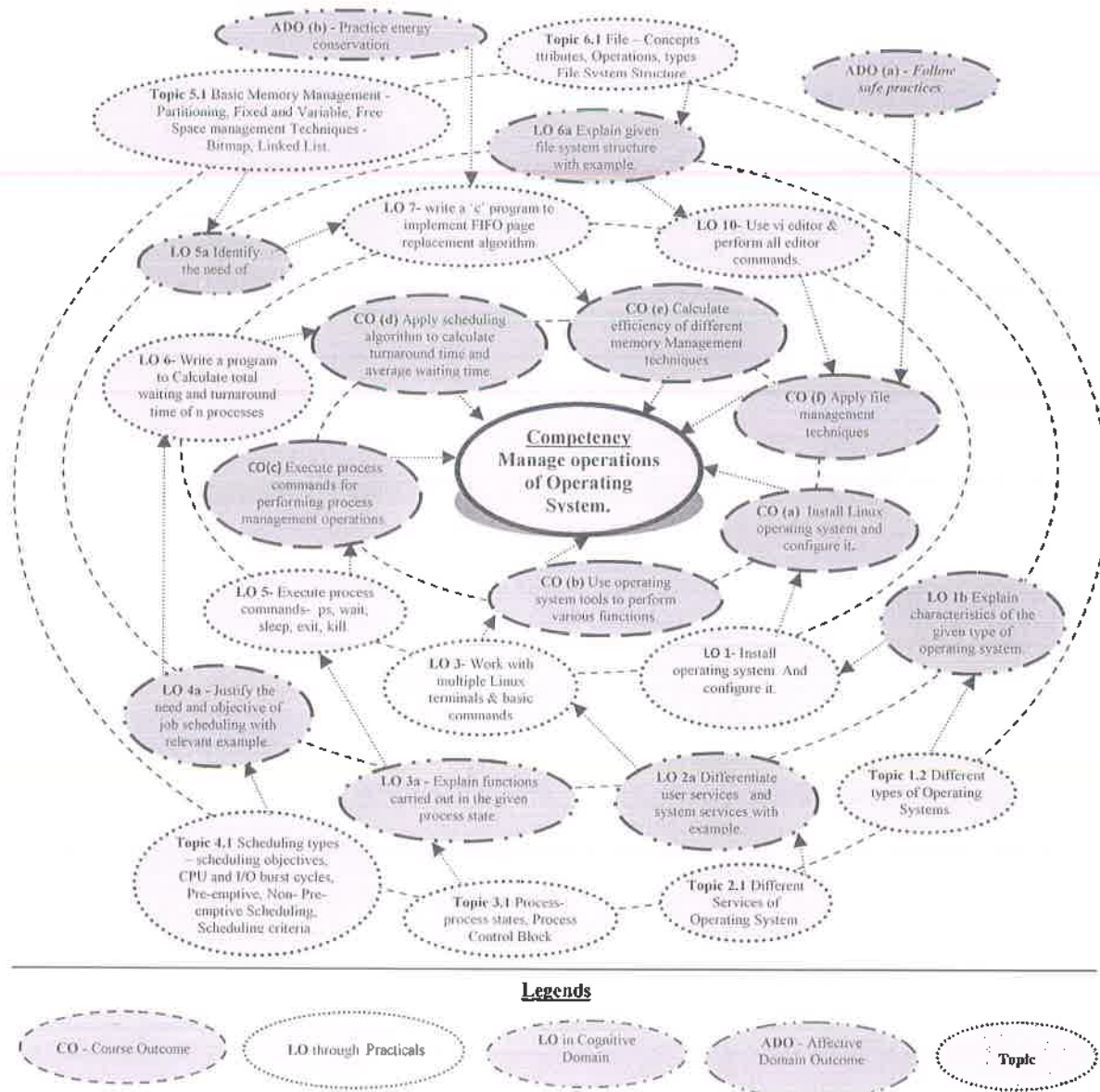
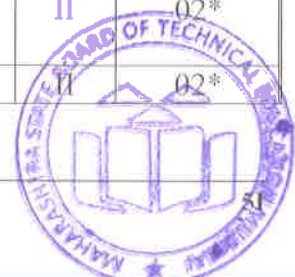


Figure 1 - Course Map

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, tty, script, man.	I	02*
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.)	II	02*



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	b) Run commands to start, stop, and restart the specified service in Linux.		
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

- 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.
- A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious 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.
- 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:

- Follow safety practices.
- 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 Component s of Operating System	2a. Start, stop, and restart the given service in Linux. 2b. Explain use of the given System call of specified OS. 2c. Explain process the OS follows in managing the given resource. 2d. Explain use of the given operating system tool.	2.1 Different Services of Operating System. 2.2 System Calls- Concept, types of system calls 2.3 OS Components: - Process Management, Main Memory Management, File Management, I/O System management, Secondary storage management. 2.4 Use of operating system tools- user management, security policy.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
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.	device management, performance monitor, task scheduler 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 permissions. 6d. Explain features of the given Raid level structure of hard disk.	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 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)

Note: 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:

- Prepare journal of practicals.
- 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:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- '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.
- 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).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.
- Encourage students to refer different websites to have deeper understanding of the subject.
- 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:

- 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.
- Make a comparative statement to calculate page fault for given page reference string by using different page replacement algorithms.
- Prepare help guide using shell script for all the major Linux commands.
- 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	Dhamdhare, Dhanjay M.	McGraw Hill, 2015 ISBN MO 978-1-25-900558-9
6	Operating System	Dr. Rajendra Kawale	Devraj Publications, Mumbai ISBN 978-81-933551-1-4

14. SOFTWARE/LEARNING WEBSITES

- [www.cs.wisc.edu/~ bart/537](http://www.cs.wisc.edu/~bart/537) lecture notes-University of Wisconsin Madison.
- www.cs.kent.edu/osf03/notes/index.html- Vilinius Gediminas Technical University
- <http://www.howstuffworks.com/operating-system1.htm>
- www.computerhope.com/jargon/o/os.htm
- [www.en.wikipedia.org/wiki/Operating system](http://www.en.wikipedia.org/wiki/Operating_system)
- https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/12_MassStorage.html



Program Name : Computer Engineering Program Group
Program Code : CO/CM/CW
Semester : Fifth
Course Title : Software Testing
Course Code : 22518

1. RATIONALE

In today's software environment writing bug-free code is challenging task, which make software testing important tool to get the quality software. Testing techniques include the process of executing a program or application with the intent of finding software bugs and verifying that the software product is fit for use. Students will learn the way to find bugs by applying types, levels and methods of software testing on applications with effective test planning approach. It also covers manual testing.

2. COMPETENCY

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

- **Apply types, levels and methods of software testing on applications.**

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:

- Apply various software testing methods.
- Prepare test cases for different types and levels of testing.
- Prepare test plan for an application.
- Identify bugs to create defect report of given application.
- Test software for performance measures using automated testing tools.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	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.

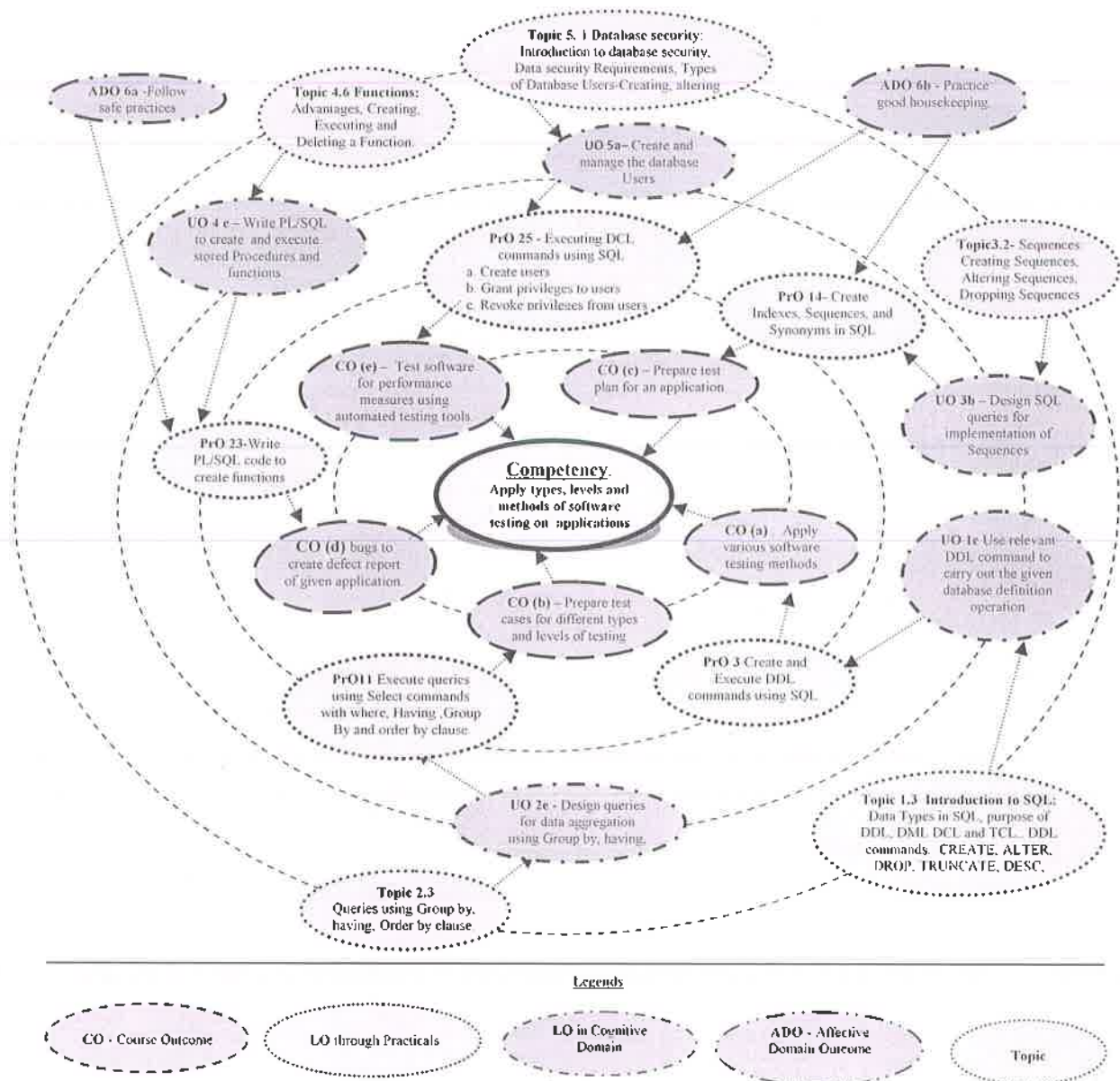


Figure 1 - Course Map

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.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify system specification & design test cases for purchase order Management.	I	02*
2	Identify system specification & design test cases for Inventory management	I	02*
3	Design test cases for simple calculator application.(BB Testing)	I	02*
4	Design test cases for railway reservation form	II	02*
5	Design test cases for e-commerce (Flipkart, Amazon) login form	II	02*



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Design test cases for Web Pages Testing any Web Sites	II	02*
7	Write program and design test cases for the following Control and decision making statement. 1) For... Loop 2) Switch...case 3) Do...While 4) If...else	II	02*
8	Prepare test plan for an identified Mobile application.	III	02*
9	Design test plan and test cases for Notepad (MS Window based) Application.	III	02*
10	Prepare defect report after executing test cases for library management system	IV	02*
11	Prepare defect report after executing test cases for Withdrawn of amount from ATM Machine.	IV	02
12	Prepare defect report after executing test cases for any login form.	IV	02
13	Design and run test cases for WordPad (MS Windows based). Using an Automated tool.	V	02*
14	Design and run test cases for MS Word application using an Automation Tool.	V	02
15	Project Assignment		04*
	Total		32

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious 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 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of system specification, designing test plan using MS Excel.	50
2	Preparation of defect report	10
3	Execution of test cases using automation tool.	20
4	Answer to sample questions	10
5	Submit report in time	10
	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. Work 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.
1.1	Computer system (Any computer system with basic configuration)	All
1.2	Selenium	V
1.3	Mantis Bug Tracker	IV
1.4	IBM Rational Functional Tester	V
1.5	Spreadsheet Package	I, II, III
1.6	Bugzila	IV

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 Basics of Software Testing and Testing Methods	1a. Identify errors and bugs in the given program. 1b. Prepare test case for the given application. 1c. Describe the Entry and Exit Criteria for the given test application. 1d. Validate the given application using V model in relation with quality assurance. 1e. Describe features of the given testing method.	1.1 Software Testing, Objectives of Testing. 1.2 Failure, Error, Fault, Defect, Bug Terminology. 1.3 Test Case, When to Start and Stop Testing of Software (Entry and Exit Criteria). 1.4 Verification and Validation (V Model), Quality Assurance, Quality Control. 1.5 Methods of Testing: Static and dynamic Testing 1.6 The box approach : White Box Testing: Inspections, Walkthroughs, Technical Reviews, Functional Testing, Code Coverage Testing, Code Complexity Testing. 1.7 Black Box Testing: Requirement Based Testing, Boundary Value Analysis, Equivalence Partitioning,
Unit- II Types and Levels of Testing	2a Apply specified testing level for the given web based application. 2b Apply Acceptance testing for given web based application. 2c Apply the given performance testing for the specified application.	2.1 Levels of testing 2.1 Unit Testing: Driver, Stub 2.2 Integration Testing: Top-Down Integration, Bottom-Up Integration, Bi-Directional Integration 2.3 Testing on Web Application: Performance Testing: Load Testing.

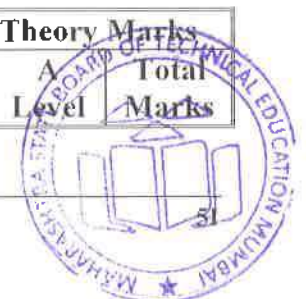


Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2d. Generate test cases for the given application using regression and GUI testing.	Stress Testing, Security Testing, Client-Server Testing 2.4 Acceptance Testing: Alpha Testing and Beta Testing, Special Tests: Regression Testing, GUI Testing,
Unit III- Test Management	3a. Prepare test plan for the given application. 3b. Identify the resource requirement of the given application. 3c. Prepare test cases for the given application. 3d. Prepare test report of executed test cases for given application.	3.1 Test Planning : Preparing a Test Plan, Deciding Test Approach, Setting Up Criteria for Testing, Identifying Responsibilities, Staffing, Resource Requirements, Test Deliverables, Testing Tasks 3.2 Test Management: Test Infrastructure Management, Test People Management. 3.3 Test Process: Base Lining a Test Plan, Test Case Specification. 3.4 Test Reporting: Executing Test Cases, Preparing Test Summary Report.
Unit-IV Defect Management	4a. Classify defects on the basis estimated impact. 4b. Prepare defect template on the given application. 4c. Apply defect management process on the given application. 4d. Write procedure to find defect using the given technique.	4.1. Defect Classification, Defect Management Process. 4.2. Defect Life Cycle, Defect Template 4.3. Estimate Expected Impact of a Defect, Techniques for Finding Defects, Reporting a Defect.
Unit –V Testing Tools and Measurements	5a. Improve testing efficiency using automated tool for given application. 5b. Identify different testing tools to test the given application. 5c. Describe Metrics and Measurement for the given application 5d. Explain Object oriented metrics used in the given testing application	5.1 Manual Testing and Need for Automated Testing Tools 5.2 Advantages and Disadvantages of Using Tools 5.3 Selecting a Testing Tool 5.4 When to Use Automated Test Tools, Testing Using Automated Tools. 5.5 5.6 Metrics and Measurement: Types of Metrics, Product Metrics and Process Metrics, Object oriented metrics in testing.

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



Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Software Testing and Testing Method	10	04	04	06	14
II	Types and Levels of Testing	12	04	06	08	18
III	Test Management	10	04	04	06	14
IV	Defect Management	08	04	02	06	12
V	Testing Tools and Measurements	08	02	04	06	12
Total		48	18	20	32	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: 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 UOs. 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 journals based on practical performed in laboratory.
- b) Give seminar on relevant topic.
- c) 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) Library Management: book issue /book stock system.
- b) Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Software Testing: Principles and Practices	Srinivasan Desikan Gopaldaswamy Ramesh	PEARSON Publisher: Pearson India 2005, ISBN: 9788177581218,
2	Software Testing: Principles, Techniques and Tools	Limaye M. G.	Tata McGraw Hill Education, New Delhi., 2007 ISBN 13: 9780070139909
3	Software Testing: Principles and Practices	Chauhan Naresh	Oxford University Press Noida –
4	Software Testing	Singh Yogesh	Cambridge University Press, Bangluru. ISBN 978-1-107-65278-1

Note: Other available testing tools can be used at institute level.

14. SOFTWARE/LEARNING WEBSITES

- a. <http://www.selenium.com>
- b. http://en.wikipedia.org/wiki/Test_automation
- c. http://en.wikipedia.org/wiki/Software_testing#Testing_tools
- d. <http://www.softwaretestingsoftware.com>
- e. www.toolsqa.com



Program Name : Computer Engineering Program Group
Program Code : CO/CM/IF/CW
Semester : Fifth
Course Title : Client Side Scripting Language (Elective)
Course Code : 22519

1. RATIONALE

JavaScript is limited featured client side programming language. JavaScript runs at the client end through the user's browser without sending messages back and forth to the server. It is widely used by the web developers to do things such as build dynamic web pages, respond to events, create interactive forms, validate data that the visitor enters into a form, control the browser etc. This course helps student to create highly interactive web pages using these features.

2. COMPETENCY

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

- **Develop Dynamic Web Pages using JavaScript.**

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:

- Create interactive web pages using program flow control structure.
- Implement Arrays and functions in Java script.
- Create event based web forms using Java script.
- Use JavaScript for handling cookies.
- Create interactive webpage using regular expressions for validations.
- Create Menus and navigations in web Pages.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	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 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.



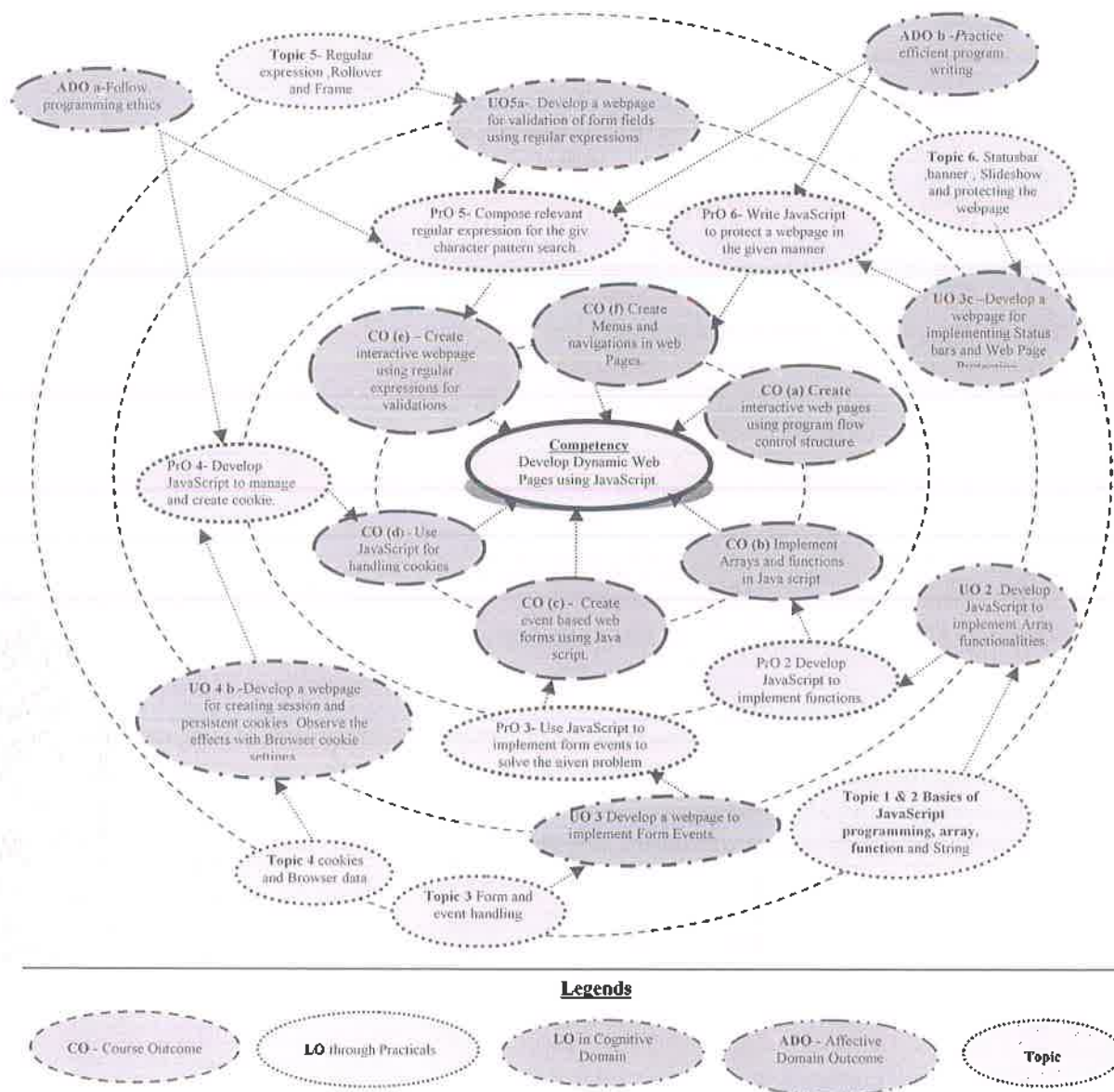


Figure 1 - Course Map

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.	Write simple javascript with HTML for arithmetic expression evaluation and message printing	I	02
2.	Develop JavaScript to use decision making and looping statements.	I	02*
3.	Develop JavaScript to implement Array functionalities.	II	02*
4.	Develop JavaScript to implement functions.	II	02*
5.	Develop JavaScript to implement strings.	II	02
6.	Create a webpage using Form Elements.	III	02*
7.	Create a webpage to implement Form Events. Part-I	III	02*



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8.	Create a webpage to implement Form Events. Part-II	III	02*
9.	Develop a webpage using Intrinsic Java Functions.	III	02*
10.	Develop a webpage for creating session and persistent cookies. Observe the effects with Browser cookie settings.	IV	02*
11.	Develop a webpage for placing the Window on the screen and working with child window.	IV	02*
12.	Develop a webpage for validation of form fields using regular expressions.	V	02*
13.	Create a webpage with Rollovers effect.	VI	02
14.	Develop a webpage for implementing Menus.	VI	02*
15.	Develop a webpage for implementing Status bars and Web Page Protection.	VI	02
16.	Develop a webpage for implementing Slideshow, banner.	VI	02*
	Total		32

Note:

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious 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.
- ii. 50% of Lab assignments must be done using traditional editor and run in different browsers so as to build up fundamental understanding capabilities of students.
- 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 %
1	Use of relevant tags and attributes	10
2	Correctness of Coding.	40
4	Testing and Debugging of the Program.	30
5	Appearance of Program Output.	10
6	Submission of report in time.	10
	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
- '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	Browser and Notepad/any Text editor/	All
2	Free Web page Designing Tool	All
3	Any IDE like Eclipse	All

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 Basics of JavaScript Programming	1a. Create object to solve the given problem. 1b. Develop JavaScript to implement the switch-case statement for the given problem. 1c. Develop JavaScript to implement loop for solving the given iterative problem. 1d. Display properties of the given object using getters and setters. 1e. Develop program using basic features of JavaScript to solve the given problem.	1.1 Features of JavaScript 1.2 Object Name, Property, method, Dot syntax, main event. 1.3 Values and Variables 1.4 Operators and Expressions- Primary Expressions, Object and Array initializers, function definition expression, property access expressions, invocation expressions. 1.5 If Statement, if...else, if..elseif, nested if statement. 1.6 Switch...case statement 1.7 Loop statement – for loop, for...in loop, while loop, do...while loop, continue statement. 1.8 Querying and setting properties and deleting properties, property getters and setters.
Unit-II Array, Function and String	2a. Create array to solve the given problem. 2b. Perform the specified string manipulation operation on the given String(s). 2c. Develop JavaScript to implement the given function. 2d. Develop JavaScript to convert the given Unicode to character form. 2e. Develop JavaScript to convert the given character to Unicode and vice-versa.	2.1 Array - declaring an Array, Initializing an Array, defining an Array elements, Looping an Array, Adding an Array element, sorting an Array element, Combining an Array elements into a String, changing elements of an Array, Objects as associative Arrays 2.2 Function – defining a function, writing a function, adding an arguments, scope of variable and arguments, 2.3 Calling a function – calling a function with or without an argument, calling function from HTML, function calling another function. Returning a value from a function 2.4 String – manipulate a string, joining a



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		string, retrieving a character from given position, retrieving a position of character in a string, dividing text, copying a sub string, converting string to number and numbers to string, changing the case of string, finding a Unicode of a character-charCodeAt(), fromCharCode().
Unit– III Form and Event Handling	3a. Write JavaScript to design a form to accept input values for the given problem. 3b. Use JavaScript to implement form events to solve the given problem. 3c. Develop JavaScript to dynamically assign specified attribute value to the given form control. 3d. Use the given intrinsic function with specified parameters.	3.1 Building blocks of a Form, properties and methods of form, button, text, text area, checkbox, radio button, select element. 3.2 Form events- mouse event, key events. 3.3 Form objects and elements. 3.4 Changing attribute value dynamically. 3.5 Changing option list dynamically 3.6 Evaluating checkbox selection 3.7 Changing a label dynamically 3.8 Manipulating form elements 3.9 Intrinsic JavaScript functions, disabling elements, read only elements.
Unit– IV Cookies and Browser Data	4a. Create cookies based on the given problem. 4b. Develop JavaScript to manage a cookie in the given manner. 4c. Write JavaScript to manipulate the specified attributes of window object in the given manner. 4d. Write JavaScript to create browser history of the given object.	4.1 Cookies – basic of cookies, reading a cookie value, writing a cookie value, creating a cookies, deleting a cookies, setting the expiration date of cookie 4.2 Browser – opening a window, giving the new window focus, window position, changing the content of window, closing a window, scrolling a web page, multiple windows at once, creating a web page in new window, JavaScript in URLs, JavaScript security, Timers, Browser location and history.
Unit –V Regular Expression, Rollover and Frames	5a. Compose relevant regular expression for the given character pattern search. 5b. Develop JavaScript to implement validations using the given regular expression. 5c. Create frames based on the given problem. 5d. Create window object as per	5.1 Regular Expression - language of regular expression, finding non matching characters, entering a range of characters, matching digits and non digits, matching punctuations and symbols, matching words, replacing a the text using regular expressions, returning the matched characters, regular expression object properties.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the given problem. 5e. Develop JavaScript for creating rollover effect for the given situation.	5.2 Frames – create a frame, invisible borders of frame, calling a child windows, changing a content and focus of a child window, writing to a child window, accessing elements of another child window. 5.3 Rollover – creating rollover, text rollover, Multiple actions for rollover, more efficient rollover.
Unit –VI Menus, navigation and web page protection	6a. Develop JavaScript to manage the given status bar. 6b. Develop JavaScript to create the given banner. 6c. Develop JavaScript to create the given slide show. 6d. Develop JavaScript to create the given Menu. 6e. Write JavaScript to protect a webpage in the specified manner.	6.1 Status bar- builds a static message, changing the message using rollover, moving the message along the status bar 6.2 Banner –loading and displaying banner advertisement. Linking a banner advertisement to url 6.3 Slide Show – creating a slide show 6.4 Menus- creating a pulldown menu, dynamically changing a menu, validating menu selection, Floating menu, chain select menu, tab menu, pop-up menu, sliding menu, highlighted menu, folding a tree menu, context menu, scrollable menu, side bar menu. 6.5 Protecting web page – hiding your code, disabling the right mouse button, JavaScript, concealing email address. 6.6 Frameworks of javascript and its application

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	Basics of JavaScript Programming	10	04	04	04	12
II	Array, Function and String	10	02	04	08	14
III	Form and Event Handling	06	02	04	04	10
IV	Cookies and Browser Data	06	02	02	04	08
V	Regular Expression, Rollover & Frames	08	02	06	06	14
VI	Menus, navigation and web page protection	08	02	04	06	12
Total		48	14	24	32	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)



Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of UOs. 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:

- a) Prepare journals based on practical performed in laboratory.
- b) Prepare powerpoint presentation or animation for understanding different Client side scripting Concepts.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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) Use different Audio Visual materials for Concept understanding.
- f) Guide student(s) in undertaking micro-projects.
- 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.
- i) 50% of Lab assignments must be done using traditional editor and run in different browsers so as to build up fundamental understanding capabilities of students.

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 is given here. Similar micro-projects could be added by the concerned faculty:



- a) Create a web page that displays buyers information entry form containing name, address, city, pin code, mail Id, Phone Number, product details , payment mode. Frame different validation rules for user inputs. Use JavaScript and regular expressions to perform error checking on user input as per validation rules.
- b) Build a simple slide show in JavaScript with six unique images. Design appropriate web page with at least two sections: with slide show in one section. When any image on this slide show is clicked display information about it in other section. Use features for controlling window locations.
- c) Design and create web pages of an institute with different sections. Use pulldown menus in one section and implement validation of menu selections. Use other sections for displaying information about respective selected menu item.
- d) Create a simple animation in JavaScript : create a basic page showing circle of white marble. Using the setTimeout() method create an animation on the page that that makes an orange marble rotate around this circle by moving the orange marble to the next location in the circle every second. Allow the user to stop the animation by placing the cursor on any marble(use clearTimeout()).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	JavaScript Demystified	Keogh, Jim	McGraw-Hill, 2015, New Delhi ISBN:0-07-060347-2
2.	Beginning JavaScript	Wilton, Paul	Wily India, New Delhi, 2015, ISBN:0-7645-5587-1
3.	Beginning JavaScript	McPeak, Jeremy and Wilton, Paul	Wily India, New Delhi, 2015, ISBN:81-265-1304-7
4.	JavaScript in 24 hours (SAMS teach yourself)	Moncur, Michael	TechMedia, New Delhi, 2015, ISBN:978-0-672-33608-9

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.w3schools.com>
- b) <http://www.nptelvideos.com>
- c) <http://www.tutorialspoint.com>.
- d) <Http://javapoint.com>



Program Name : Computer Engineering Program Group
Program Code : CO/CM/IF/CW
Semester : Fifth
Course Title : Advanced Computer Network (Elective)
Course Code : 22520

1. RATIONALE

The modern computer network includes different routing protocols and applying the concepts of network, transport and application layer protocols. In order to work with existing technology in building large, complex networked systems, students must be acquainted with the principles, architectures, and protocols used in modern networked systems. This course covers advanced computer network protocols, and advanced principles of the design of computer networks. After completing this course students will be able to configure various TCP/IP protocols at different layers.

2. COMPETENCY

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

- **Configure network protocols at different layers of TCP/IP protocol set.**

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:

- Implement Network Layer Protocols.
- Configure IPv6 Network.
- Choose routing protocol in the given network situation.
- Implement different Transport Layer Protocols.
- Configure various Application Layer Protocols.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme				Credit (L+T+P)	Examination Scheme											
L	T	P	Theory						Practical							
			Paper Hrs.		ESE		PA		Total		ESE		PA		Total	
Max	Min	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.

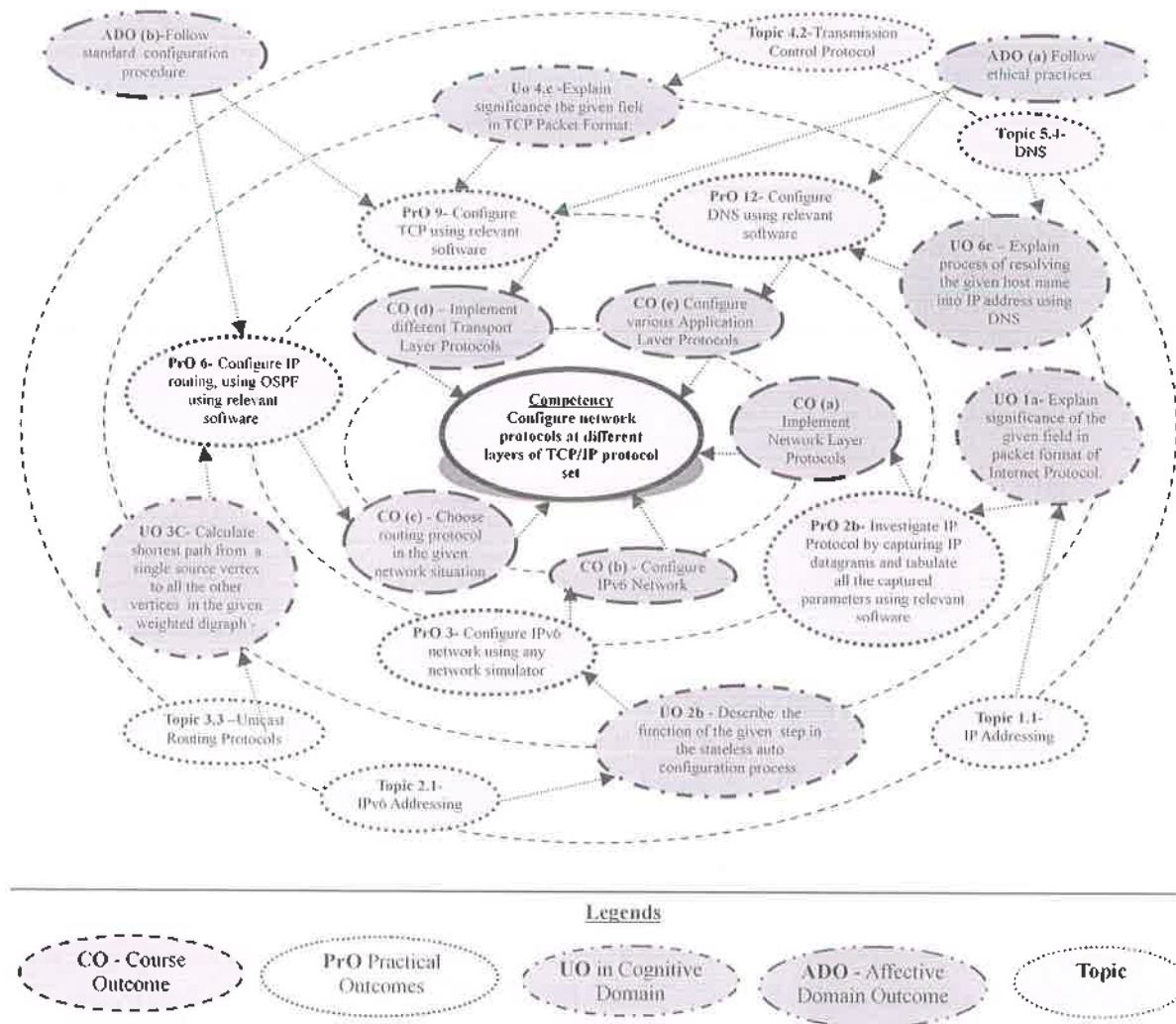


Figure 1 - Course Map

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.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Given an IP address, network mask, and subnetwork mask, determine other information and implement it about the IP address such as: i. The subnet address of this subnet. ii. The broadcast address of this subnet. iii. The range of host addresses for this subnet. iv. The maximum number of subnets for this subnet mask. v. The number of hosts for each subnet. vi. The number of subnet bits.	I	2

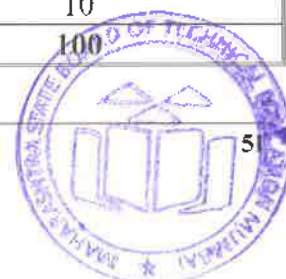


S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	vii. The number of this subnet.		
2.	a. Capture ICMPv4 packets generated by utility programs like ping, traceroute and tabulate all the captured parameters using relevant software b. Investigate IP Protocol by capturing IP datagrams and tabulate all the captured parameters using relevant software	I	2*
3.	Configure IPv6 network using any network simulator.	II	2*
4.	Configure IP static routing using relevant software.	III	02
5.	Configure IP routing with RIP using relevant software.	III	02*
6.	Configure IP routing with OSPF using relevant software	III	02*
7.	Configure User Datagram Protocol (UDP) Part-I using relevant software.	IV	02*
8.	Configure User Datagram Protocol (UDP) Part-II using relevant software.	IV	02*
9.	Configure Transmission Control Protocol (TCP) using relevant software.	IV	02*
10.	Run different STCP commands.	IV	02
11.	Configure Dynamic Host Configuration Protocol (DHCP) using relevant software.	V	02*
12.	Configure Domain Name Server (DNS) using relevant software.	V	02*
13.	a. Configure File Transfer Protocol (FTP) using relevant software. b. Configure Hypertext Transfer Protocol (HTTP) using relevant software.	V	02*
14.	a. Use Telnet to login a remote machine. b. Connect remote machine using Secure Shell (SSH).	V	02*
15.	Configure SMTP, POP3 and IMAP using relevant software.	V	02*
16.	Configure MIME and SNMP using relevant software.	V	02
	Total		32

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practicals 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.
- ii. 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 %
1.	Completion of given task.	25
2.	Correctness of the given task.	50
3.	Answer to sample questions.	15
4.	Submit report in time.	10
	Total	



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:

- Follow safety practices.
- Practice good housekeeping.
- Work as a leader/a team member.
- Follow standard configuration procedures.
- 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, connected to LAN)	All
2	Wireshark or any other similar software to capture and investigate packets	1, 2
3	Cisco Packet Tracer or any other similar software	3 to 16

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 Network Layer and Protocols	1a. Explain significance of the given field in the packet format of Internet Protocol. 1b. Implement IP addressing for the given network. 1c. Explain significance of the given field in packet format of ICMPv4. 1d. Explain the given inefficiency in Mobile IP.	1.1 IP Addressing: Address Space, Notations, Classfull addressing, Classless addressing, Network Address Translation (NAT). 1.2 Internet Protocol (IP): Datagram Format, Fragmentation, Options. 1.3 ICMPv4: Messages, Debugging Tools, ICMP Checksum. 1.4 Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP. 1.5 Virtual Private Networks (VPN) Technology.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II Next Generation IP	2a. Map the given IPv4 address to IPv6 address. 2b. Describe function of the given step in the stateless auto configuration process. 2c. Outline the given strategy of Transition from IPv4 to IPv6. 2d. Explain significance of the given field in Datagram format of IPv6.	2.1 IPv6 Addressing: Representation, address space, address space allocation, Autoconfiguration, Renumbering. 2.2 Transition from IPv4 to IPv6: Dual Stack, Tunneling, Header Translation. 2.3 IPv6 Protocol: Packet format, Extension Header.
Unit III- Unicast and Multicast Routing Protocols	3a. Choose relevant routing Protocol for the given network situation. 3b. Compare Dynamic Routing and Static Routing on the given aspect. 3c. Calculate shortest paths from a single source vertex to all the other vertices in the given weighted digraph. 3d. Explain functioning of the given multicast routing protocol.	3.1 Introduction: Inter-domain, Intra-domain Routing. 3.2 Routing Algorithms: Distance Vector Routing, Bellman–Ford algorithm, Link State Routing, Path Vector Routing. 3.3 Unicast Routing Protocols: Internet Structure, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol Version 4 (BGP4). 3.4 Introduction: Unicast, Multicast and Broadcast. 3.5 Intradomain Multicast Protocols: Multicast Distance Vector (DVMRP), Multicast Link State (MOSPF), Protocol Independent Multicast (PIM).
Unit-IV Transport Layer Protocols	4a. Explain significance of the given field in UDP Packet format. 4b. Describe the given State Transition of TCP. 4c. Explain significance of the given field in TCP Packet format. 4d. Describe the given field in the packet format of SCTP. 4e. Explain the functioning of the given Protocol with Flow and Error control by taking an example.	4.1 User Datagram Protocol: User Datagram, UDP Services, UDP Applications. 4.2 Transmission Control Protocol: TCP Services, TCP features, Segment, A TCP Connection, State Transition Diagram, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers, Options. 4.3 SCTP: SCTP Services, SCTP Features, Packet Format, An SCTP Association, Flow Control, Error Control.
Unit –V Application Layer	5a. Explain function of the given application layer protocol. 5b. Explain function of the given	5.1 World Wide Web and HTTP 5.2 File Transfer: FTP and TFTP 5.3 Electronic Mail: Architecture



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
protocols	FTP command. 5c. Explain working of the given components in the Architecture of Electronic Mail. 5d. Explain process of resolving the given host name into IP address using DNS. 5e. Explain working of the given Remote Login Protocol.	Web-Based Mail, Email Security, SMTP, POP, IMAP and MIME, SNMP. 5.4 DNS – Concept of Domain name space, DNS operation. 5.5 DHCP – Static and Dynamic Allocation, DHCP Operation. 5.6 Remote Login: TELNET and SSH.

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	Network Layer and Protocols	06	02	02	04	08
II	Next Generation IP	08	02	04	04	10
III	Unicast and Multicast Routing Protocols.	10	02	04	08	14
IV	Transport Layer Protocols	12	02	08	08	18
V	Application Layer Protocols.	12	04	08	08	20
Total		48	12	26	32	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: 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 UOs. 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:

- Prepare journals based on practical performed in laboratory.
- Give seminar on Identified topic.
- 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:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- 'L' in item No. 4 does not mean only the traditional lecture method. In addition, types of teaching methods and media that are to be employed to develop the outcome.



- 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 topic.
- 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 is given here. Similar micro-projects could be added by the concerned faculty:

- i. Prepare one Static and One dynamic Network with DHCP server. Use Routing Protocol to route packets between these networks using Cisco packet tracer or any other similar software.
- ii. Setup a FTP server and client on one network. Transfer files from Client to server and vice versa.
- iii. (a) Create DNS,
(b) Create Web server,
(c) Serve an HTML page on web server and call it on browser through DNS.
- iv. Set-up a mailing system of users on intranet.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Data Communication and Networking 5E	Forouzan Behrouz A.	McGraw Hill Education (India), New Delhi, 2005, ISBN-13:978-1-25-906475-3
2	Internetworking with TCP/IP, Volume I, Fourth Edition.	Comer Douglas E.	Prentice Hall of India Private Limited, New Delhi, 2014 ISBN-81-203-2065-4
3	Computer Networks, Fourth Edition	Tanenbaum Andrew S.	PHI Learning, New Delhi- 2014 ISBN-81-203-2175-8



4	Advanced Computer Network	B.M. Harwani and DT Editorial Services	Dreamtech New Delhi- 2014 ISBN 978-93-5004-013-3
5	Computer Networks Principles, Technologies And Protocols For Network Design	Natalia Olifer, Victor Olifer	Wiley ISBN

14. SOFTWARE/LEARNING WEBSITES

- a) TCP/IP Illustrated, Volume 1 The Protocols W. Richard Stevens
- b) <http://study-ccna.com/>
- c) <http://www.packettracernetwork.com/>
- d) <https://www.tutorialspoint.com/listtutorials/networking/1>
- e) www.txv6tf.org/wp-content/uploads/2010/08/Muhummad-Tutorial-ipv6-basics.pdf
- f) <http://cnp3book.info.ucl.ac.be/2nd/html/protocols/bgp.html>
- g) <https://campus.barracuda.com/product/nextgenfirewallf/doc/46209264/dynamic-routing-protocols-ospf-rip-bgp/>
- h) <http://www.ciscopress.com/articles/article.asp?p=2180210andseqNum=5>
- i) http://www.allsyllabus.com/aj/note/Computer_Science/Computer%20Networks%20-%20II/



Program Name : Computer Engineering Program Group
Program Code : CO/CM/CW
Semester : Fifth
Course Title : Advanced Database Management Systems (Elective)
Course Code : 22521

1. RATIONALE

Advanced database management systems contain comprehensive contents on various concepts related to database systems, database design and management. Broadly it discusses about parallel and distributed database systems, database transactions, big data management and advances in database data. The student will get a detailed introduction about database administration and management, the role of machine learning in big data management. This course includes study of structured and unstructured database like MongoDB, SQL and XML for data management. The concept big data is used in today's information driven business world for managing big data. After learning this subject student will be able to use ADBMS as a backend for developing database.

2. COMPETENCY

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

- Apply Advanced Database Management Systems concepts using MongoDB and XML

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:

- Differentiate various database architectures.
- Use Object Oriented and Advanced XML queries on Database.
- Manipulate data using MongoDB commands.
- Use Data Mining And Data Warehousing Concepts.
- Use Big Data Concepts.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	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.

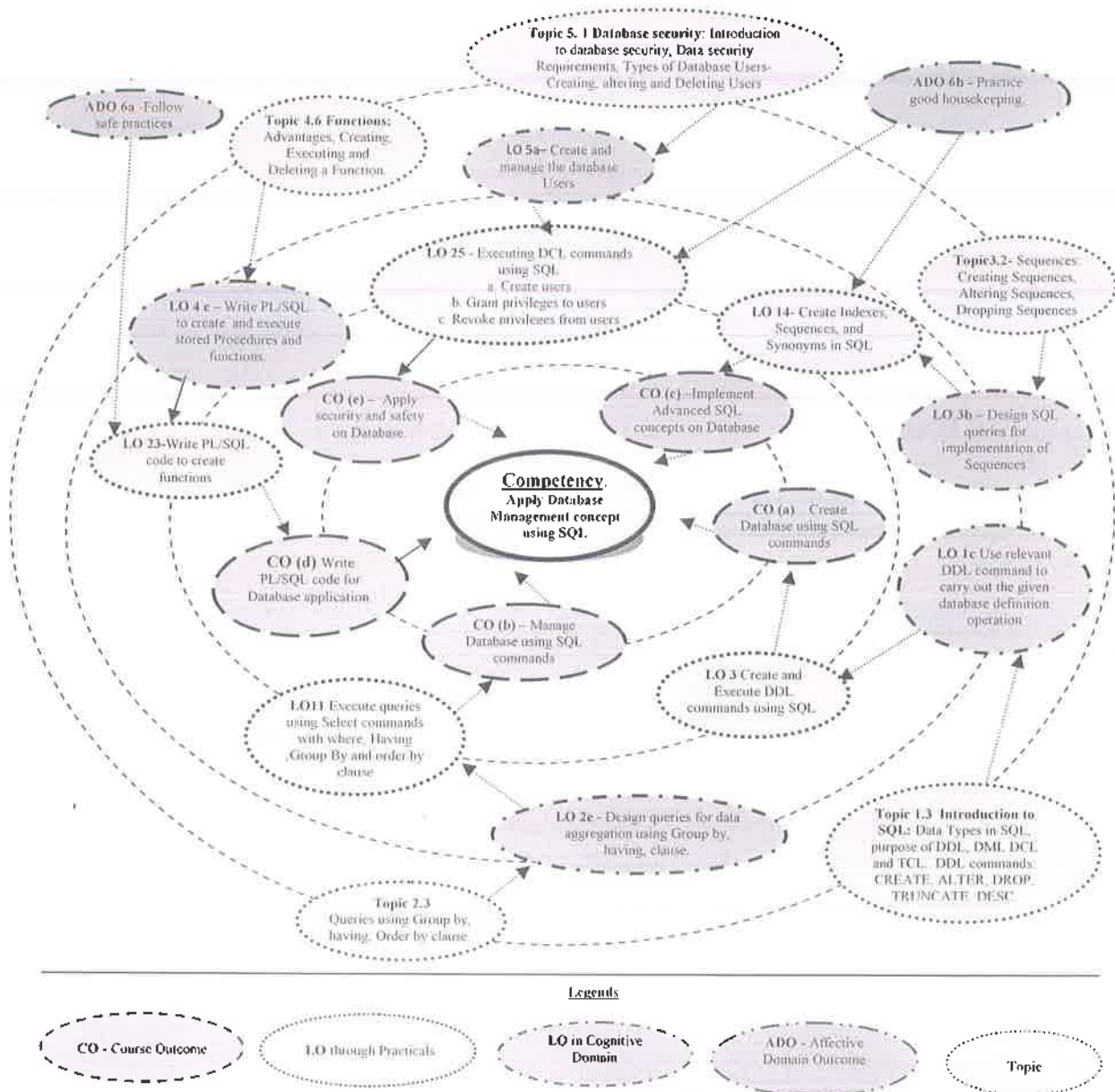


Figure 1 - Course Map

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.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Implementing Locking protocols	III	02
2.	Install and configure Database system (such as MySQL, MongoDB or any other relational database system)	III	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Implementing Locking protocols	I	02
3.	Create database using XML attributes and Elements.	II	02
4.	Implement queries based on FLOWER expressions and joins using XQuery.	II	02
5.	Implement queries based on Nested queries and sorting of results using XQuery.	II	02
6.	Implement queries based on functions and types using XQuery.	II	02
7.	Execute queries using structured type in SQL	II	02
8.	Execute queries using type inheritance and table inheritance in SQL	II	02
9.	Implement queries using Array and Multiset types in SQL	II	02
10.	Execute queries using object identity and reference types in SQL	II	02
11.	Design and Develop MongoDB Queries using basic operations	III	02
12.	Implement aggregation Queries using MongoDB	III	02
13.	Implement MongoDB Queries Using find() function	III	02
14.	Implement aggregation Queries in MongoDB through MapReduce	III	02
15.	Install and configure Any data mining tool (like WEKA) .	IV	02
16.	Make use of installed data mining tool (like WEKA)	IV	02
Total			32

Note

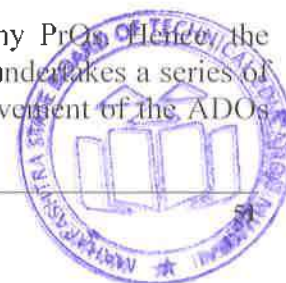
- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Installation and configuration of database system	10
b.	Coding of queries and MongoDB programming	40
c.	Quality of result displayed by queries.	30
d.	Answer to sample questions	10
e.	Submit report in time	10
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. Work 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.

17. 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	Exp. S. No.
1.1	Computer system (Any computer system with basic configuration)	All
1.2	Any RDBMS software (MySQL/Oracle/SQL server/MongoDB or any other)	All

18. 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 Database Architecture	1a. Describe the given client-server Database Model. 1b. Use the given locking protocols for concurrency control. 1c. Apply parallel and distributed database techniques in given situation. 1d. Differentiate between Parallel and Distributed Databases.	1.1 Introduction to client-server Database Model: Two-Tier Client server model, Three-Tier Client server model. 1.2 Concurrency Control Techniques: Concurrency control protocols: Locked Based protocols, granting of locks, Two Phase Locking protocol. 1.3 Introduction to parallel databases: Parallel database system architecture, Types of parallelism, Parallel Database Implementation. 1.4 Introduction to distributed databases: Distributed database system architecture, Benefits of distributed database system, Issues with distributed database systems.
Unit II- Object Based Databases and XML	2a Create the given object based database using SQL 2b Write given SQL queries using Table Inheritance 2c Write given SQL queries using Array and Multiset. 2d Implement SQL queries to refer the given object using object identity. 2e Write XML queries on given data.	2.1 Object Based Databases overview 2.2 Complex data types 2.3 Structured types and inheritance in SQL 2.4 Table inheritance 2.5 Array and multiset types in SQL 2.6 Object identity (OI) and reference types in SQL 2.7 XML: Introduction, structure of XML data, XML document schema ,Xpath, XQuery:FLOWER Expressions, Joins,Nested Queries, Sorting functions, Functions and types
Unit– II	3a. Differentiate structured and	3.1 Structured versus Unstructured Data



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Advanced Database Techniques	Unstructured Data. 3b. Use NoSQL database to solve given queries. 3c. Use MongoDB to solve given queries. 3d. Differentiate SQL and NoSQL databases. 3e. Write query to execute find() function on given data. 3f. Implement basic operations performed on MongoDB shell on given data. 3g. Write query using aggregate() method on given data.	3.2 NoSQL database concepts: Types of NoSQL databases, NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system. 3.3 NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types ,Arrays, Embedded Documents 3.4 Querying with MongoDB: find() function, specifying which keys to return, query criteria, OR queries, Types specific querying 3.5 Aggregation Introduction: Aggregation Pipeline, Aggregation using Map reduce, Single purpose aggregation
Unit –IV Advances in Databases	4a. Define data mart, meta data 4b. Explain architecture of data warehouse 4c. Analyze given data using data mining. 4d. Describe the features of BI and BI components framework. 4e. Explain use of spatial databases in a given situation.	4.1 Introduction to Data Warehouse :Characteristics, Types of Data Warehouse Architecture, Data Marts, Data Warehousing Lifecycle, Data Warehouse Development 4.2 Introduction to Data Mining Techniques: Data mining technology and its relation to data warehousing, Association rules, classification and clustering, Applications of data mining. 4.3 Introduction to business Intelligence: Features, frameworks, Types and approaches for machine learning 4.4 Introduction to Multimedia Databases, Mobile Databases and digital databases
Unit-V Big Data Management	5.a Analyze the given situation for the use of Big data. 5.b Describe the given architecture of Hadoop. 5.c Explain given components of Hadoop. 5.d Explain use of cloudera in given situation. 5.e Explain given features of R-programming.	5.1 Big Data 5.2 Introduction to Hadoop: Building Blocks and Components, Hadoop architecture, HBase, HIVE, Solid -State Drive 5.3 Cloudera, Oracle cloud, 5.4 Introduction to R-programming

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	Database Architecture	08	04	04	04	12
II	Object Based Databases and XML	14	04	04	10	18
III	Advanced Database Techniques	12	06	04	06	16
IV	Advances in Databases	08	02	08	04	14
V	Big Data Management	06	02	04	04	10
Total		48	18	24	28	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: 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 UOs. 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:

- Prepare journals based on practical performed in laboratory.
- 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:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- '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.
- 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).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.
- Encourage students to refer different websites to have deeper understanding of the subject.
- Observe continuously and monitor the performance of students in Lab.
- Demonstrate students thoroughly before they start doing the practice.
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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. Develop and maintain XML database for Employee information System.
- b. Design and develop MongoDB database for library management system.
- c. Perform preprocessing of data using any data mining tool (like WEKA).
- d. Install and configure Hadoop.
- e. Perform database connectivity with any front end tool.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Database Management Systems Application	Kogent Learning Solutions Inc.	Dreamtech Press 2014, ISBN-978-93-5119-476-7
2	Database System Concepts	Korth Henery	Tata McGraw Hill Education, 6 th Edition ,ISBN -13:978-93-329-0138-4
3	Complete Reference: Mysql	Vaswani Vikram	McGraw Hill Education, ISBN-13: 9780070586840
4	SQL, PL/SQL The Programming Language of ORACLE	Bayross Ivan	BPB Publications, 3 rd Edition ISBN-13: 978-8176569644

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.tutorialspoint.com>
- b) <https://www.w3schools.com>
- c) <http://db.ucs.d.edu/static/cse132b-sp01/oql.htm>
- d) <https://docs.mongodb.com/manual/tutorial/install-mongodb-on-windows/>
- e) <http://www.cs.stir.ac.uk/courses/CSC9T6/practicals/1%20Data%20Mining/1%20-%20Weka%201.pdf>

