GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University)
VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A^+ Grade

REGULATIONS AND SYLLABUS

of

B.Tech. Computer Science and Business Systems

(w.e.f. 2019-20 admitted batch)

Vision and Mission of university

Vision

To become a global leader in higher education.

Mission

To impart futuristic and comprehensive education of global standards with high sense of discipline and social relevance in a serene and invigorating environment.

Vision and Mission of the department

Vision

Excel in computer science and engineering education with international standards for global employment and research.

Mission

- *Create an excellent academic ambience that promotes innovation and research.*
- *Impart quality education through well designed curriculum experiential learning in tune with the changing needs of the industry.*
- *Collaborate with world class academic institutions and software industries for mutual benefit.*
- *Produce competent and socially committed graduates having creative skills and ethical values.*

Program Outcomes (POs)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess

societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

Upon successful completion of B.Tech.(Computer Science and Business Systems) Program, student will be able to:

PSO1: identify, formulate and solve engineering problems to provide efficient solutions.

PSO2: design and develop computer-based applications of varying complexities in emerging areas of Computer Science and Engineering.

PSO3: apply the skills learnt through internships and collaborative projects with industry in real time project development.

B. Tech. Computer Science and Business Systems

REGULATIONS

(w.e.f. 2019-20 admitted batches)

1. ADMISSION

1.1 Admission into B. Tech. in Computer Science and Business Systems program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1 A first class in 10+2 or equivalent examination approved by GITAM (Deemed to be University) with subjects Physics, Chemistry and Mathematics.

2.2 Admission into B.Tech. will be based on an All India Entrance Test (GITAM Admission Test - GAT) conducted by GITAM/Specified rank holders of JEE mains/EAMCET (AP & TS) are considered. The rules of reservation of statutory bodies, wherever applicable, will be followed.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from the academic year of 2015-16 admitted batch and revised in 2019-20 academic year, based on guidelines of the statutory bodies in order to promote:

- Activity based learning
- Student centered learning
- Cafeteria approach
- Learning at their own pace
- Interdisciplinary learning

3.2 Course Objectives, Learning Outcomes and Course Outcomes are specified, focusing on what a student should be able to do at the end of the course and program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program consists of courses based on humanities and social sciences, basic sciences, basic engineering, program core, program electives, open electives, interdisciplinary electives, industry internship, laboratory, mandatory courses and project work.

S. No.	Broad Course Classification	Course Group/ Category	Course Description
1	Foundation Courses	Basic Sciences	Mathematics, physics, chemistry and life sciences.
		Engineering Sciences	Fundamental engineering courses
		Humanities and Social Sciences	Related to English, humanities, social sciences and management
2	Core Courses	Program Core	Branch specific and mandatory core courses
3	Elective Courses	Program Electives	Supportive to the discipline with expanded scope in a chosen track of specialization or cross track courses
		Interdisciplinary Electives	Interdisciplinary exposure to nurture the interest of a student in other department courses
		Open Electives	Common to all disciplines that nurtures general interest of a student
4	Core Activities	Project Work	University or industry
		Internship	Training in industry or research organization
5	Mandatory Courses		Non-credit mandatory courses on Induction Program, Environmental Sciences, Indian Constitution, Essence of Indian Traditional Knowledge.

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week.

- One credit for each Lecture/Tutorial hour per week.
- One credit for two hours of Practical's per week.

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in the academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 85% in all the courses put together in any semester will not be permitted to attend the end semester examination and will not be allowed to register for subsequent semester of study. He/she has to repeat the same semester along with his/her juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance of the students whose attendance is between 75% and 84% on medical grounds and on payment of prescribed fee.

8. EVALUATION

8.1 Assessment of the performance of a student in theory courses shall be based on two components: Continuous Evaluation (40 marks) and Semester-end Examination (60 marks).

8.2 A candidate has to secure a minimum of 40% in any theory course in the two components (ref 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Practical courses are assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure pass grade.

8.4 For courses having both theory and practical components, 70% of the weightage will be given for theory component and 30% weightage for practical component. The student has to acquire 40% in the semester end theory examination. However, student must have secured overall 40% (Theory + Practical) to secure pass grade.

8.5 Project Work/ Industrial internship courses are assessed under continuous evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure pass grade.

8.6 Mandatory courses are assessed for PASS or FAIL only. No credits will be assigned to these courses. If a student secures more than 40 out of 100 marks, he / she will be declared PASS, else FAIL. PASS grade is

necessary to be eligible to get the degree.

8.7 Mandatory courses Induction Program/Environmental Sciences/Indian Constitution/Essence of Indian Traditional Knowledge are assessed for satisfactory or not satisfactory only. No grade will be assigned. A student has to undergo two hours training per week in any one of the above in both I and II semesters and should obtain satisfactory grade to be eligible to get degree.

The details of Assessment Procedure are furnished in Table 1.

Table 1: Assessment Procedure

S.No	**Component of Assessment**	**Types of Assessment**	**Marks Allotted**	**Scheme of Evaluation**
1	Theory courses	Continuous Evaluation	40	(i) Thirty (30) marks for mid semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations.
		Semester End Examinations	60	Sixty (60) marks for semester-end Examinations.
		Total	100	
2	Practical courses	Continuous Evaluation	100	(i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.

3	Theory and Practical combined courses	(a) Theory component: continuous evaluation and semester end examination. (b)Practical component: continuous evaluation Total	100 100 200	70% of the weightage will be given for theory component. Evaluation for theory component shall be same as S. No 1 as above. 30% weightage for practical components. Evaluation for practical component shall be same as S. No 2 as above
4	Project work (VII & VIII Semesters)	Continuous Evaluation	100	i) Forty (40) marks for periodic evaluation on originality, innovation, sincerity and progress of the work assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation by a panel of examiners. iii) Thirty (30) marks for final report, presentation and Viva-voce by a panel of examiners.
5	Industrial Internship (VI&VII Semester)	Continuous Evaluation	100	i) Thirty (30) marks for performance assessed by the Supervisor of the host Industry/ Organization. Submission of Project Completion Certificate from host organization is mandatory. ii) Forty (40) marks for Report and Seminar presentation on the training, assessed by the Teacher Coordinator. iii) Thirty (30) marks for presentation on the training, before a panel of examiners.
6	Mandatory Courses	Continuous Evaluation	100	Sixty (60) marks for midterm semester examinations. Three midterm examinations shall be conducted for 30 marks each; performance in best two shall be taken into consideration. Forty (40) marks for Quizzes, Assignments and Presentations.

9. RETOTALING & REVALUATION

9.1 Retotaling / revaluation of any theory answer script of the semester-end examination is permitted on request by a student by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by student by paying the prescribed fee within one week after the announcement of the results.

9.3 A student who has secured 'F' grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

9.4 A student who has secured 'F' grade in a practical course shall have to attend special instruction classes held during summer.

9.5 A candidate who has secured 'F' grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examinations held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

9.6 A student who has secured 'F' Grade in project work / Industrial Training shall be permitted to submit the report only after satisfactory completion of the work and viva-voce examination.

10. PROVISION FOR VERIFICATION OF ANSWER BOOK AND CHALLENGE EVALUATION

10.1 If a student is not satisfied with his/her grade after revaluation, the student can apply for verification of answer book on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner on payment of prescribed fee. The challenge valuation fee will be refunded, if the student is successful in the appeal by securing a better grade.

11. SUPPLEMENTARY AND SPECIAL EXAMINATIONS

11.1 The odd (I, III, V, VII) semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

11.2 The even (II, IV, VI, VIII) semester supplementary examinations will be conducted after conducting regular odd semester examinations during October/November.

11.3 A student who has completed period of study and still has "F" grade in final semester courses is eligible to appear for special examination.

12. PROMOTION TO THE NEXT YEAR OF STUDY

12.1 A student shall be promoted to the next academic year only if he/she passes60% of the credits till that academic year.

12.2 Whenever there is a change in syllabus or curriculum, he/she has to continue the course with new syllabus and regulations after detention as per the equivalency established by the BoS to continue his/her further studies.

13. MASSIVE OPEN ONLINE COURSES

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses upto fourth semester are permitted to register for MOOCs from fifth semester onwards up to a maximum of 15 credits from program elective/ interdisciplinary elective/ open elective courses. However, the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency for these courses will be decided by the respective Board of Studies (BoS).

14. ELIGIBILITY FOR AWARD OF THE B. Tech. DEGREE

14.1 The curriculum of the eight semesters B.Tech. program is designed to have a total of 160 credits for the award of B.Tech. degree.

14.2 Duration of the program: A student is ordinarily expected to complete the B. Tech program in eight semesters of four years. However, a student may complete the program in not more than eight years including study period.

14.3 However, the above regulation may be relaxed by the Vice- Chancellor in individual cases for cogent and sufficient reasons.

14.4 A student shall be eligible for award of the B.Tech. Degree if he / she fulfils the following conditions:

i) Registered and successfully completed all the courses and project as per the curriculum.

ii) Successfully acquired the minimum required credits as specified in the curriculum in the branch of his/her study within the stipulated time.

iii) Has no dues to the Institute, Hostels, Libraries, NCC/NSS etc., and no disciplinary action is pending.

15. B. Tech (HONORS)

A student who secured 8.0 CGPA or above up to IV semester is eligible to register for B. Tech (Honors) degree. The student has to complete additional 20 credits (six theory courses + seminar) as approved by the respective DC to secure B. Tech (Honors). The courses will be approved by DC of respective campuses.

16 GRADING SYSTEM

16.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

S.No.	Grade	Grade Points	Absolute Marks
1	O (Outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

16.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, subject to securing CGPA of 5.0 at the end of the program to declare pass in the B. Tech program.

17. GRADE POINT AVERAGE

17.1 A Grade Point Average (GPA) for a semester is calculated as follows:

$$GPA = \frac{\Sigma[C^* G]}{\Sigma C}$$

where,

C = number of credits for the course.

G =grade points obtained by the student in the course.

17.2 The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester, in all the semesters upto that particular semester.

17.3 CGPA required for classification of class after the successful completion of the

program is shown in Table 3.

Table 3: CGPA required for award of Class

Class	CGPA Required
First Class with Distinction	$\geq$8.0*
First Class	$\geq$ 6.5
Second Class	$\geq$ 5.5
Pass Class	$\geq$ 5.0

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses in the first attempt.

18. BETTERMENT OF GRADES

18.1 A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations for only upto eight theory courses of his/her choice, conducted in summer vacation along with the special examinations.

18.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

19. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice-Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

B.E. /B.Tech. Computer Science and Business Systems

(Effective from the academic year 2019-20 admitted batch)

Semester I

S.No.	Course code	Course	Category	L	T	P	C
1	19EMA107	Discrete Mathematics	BS	3	1	0	4
2	19EMA109	Statistics, Probability and Calculus*	BS	3	0	0	3
3	19ECB131	Fundamentals of Computer Science	PC	3	0	4	5
4	19EEE133	Principles of Electrical Engineering	ES	2	0	2	3
5	19EPH137	Physics for Computing Science**	BS	2	0	2	3
6	19EHS101	Business Communication and Value Science I***	HS	1	0	2	2
7	19EMC183	Induction Program	MC	2	0	0	0
Total				**20**			

Note:

1. Statistics, Probability and Calculus*: The course was offered for the 2019-20 admitted batch with course title as “Introductory Topics In Statistics, Probability and Calculus”

2. Physics for Computing Science**: The course was offered for the 2019-20 admitted batch with course title as “Fundamentals of Physics”. Minor Modifications has been suggested in the syllabus w.e.f 2020-21 admitted batches.

3. Business Communication and Value Science I***: This course was offered for 2019-20 admitted batch, with LTPC as 2 0 0 2

Semester II

S.No.	Course Code	Course	Category	L	T	P	C
1	19EMA108	Linear Algebra	BS	3	1	0	4
2	19EMA110	Statistical Methods [$]	BS	3	1	0	4
3	19ECB132	Data Structures and Algorithms	PC	3	1	4	5
4	19EEC132	Principles of Electronics Engineering[$$]	ES	2	0	2	3
5	19EHS102	Fundamentals of Economics	HS	2	0	0	2
6	19EHS104	Business Communication and Value Science II	HS	2	0	0	2
7	19EMC182	Environmental Sciences (Non Credit)	MC	2	0	0	0
Total				**20**			
4 Weeks – Exchange Program among the Participating Institutes[*]							

1. Statistical Methods [$:] For the admitted batch of 2019-20, this course was offered with course title as "Statistical Modeling".

2. Principles of Electronics Engineering[$$]: For the admitted batch of 2019-20, this course was offered with course title as "Principles of Electronics".

*** Note:**

1. Exchange Program is optional
2. To be mutually decided between participating institutes
3. TCS will have no role to play in the exchange program

Semester III

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB201	Formal Language and Automata Theory	PC	3	0	0	3
2	19ECB231	Computer Organization & Architecture	PC	3	0	4	5
3	19ECB233	Object Oriented Programming	PC	2	0	4	4
4	19EMA209	Computational Statistics	BS	3	0	2	4
5	19ECB235	Software Engineering	PC	3	0	2	4
6	19EMC281	Constitution of India (Non Credit)	MC	2	0	0	0
Total						**20**	

Semester IV

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB232	Operating Systems	PC	3	0	2	4
2	19ECB234	Database Management Systems	PC	3	0	2	4
3	19ECB236	Software Design with UML	PC	2	0	2	3
4	19EID204	Introduction to Innovation, IP Management and Entrepreneurship	ES	3	0	0	3
5	19EID236	Design Thinking	ES	2	0	2	3
6	19EME236	Operations Research	MS	2	0	2	3
7	19EMC282	Essence of Indian Traditional Knowledge (Non Credit)	MC	2	0	0	0
Total						**20**	
4 Weeks – Exchange Program among the Participating Institutes*							

*** Note:**

1. Exchange Program is optional
2. To be mutually decided between participating institutes
3. TCS will have no role to play in the exchange program

Semester V

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB331	Design and Analysis of Algorithms	PC	3	0	4	5
2	19ECB333	Compiler Design	PC	3	0	4	5
3	19EID303	Fundamentals of Management	MS	2	0	0	2
4	19EID305	Business Strategy	MS	2	0	0	2
5	19EHS303	Business Communication & Value Science III	HS	2	0	0	2
6	19ECB34X	Elective I	PE	2	1	2	4
7	19ECB391	Mini Project	PW	0	0	2	1
Total				**21**			

Semester VI

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB332	Computer Networks	PC	3	0	4	5
2	19ECB334	Information Security	PC	3	0	2	4
3	19ECB336	Artificial Intelligence	PC	3	0	2	4
4	19EID302	Financial & Cost Accounting	MS	2	0	0	2
5	19EHS331	Business Communication & Value Science IV	HS	2	0	2	3
6	19ECB34X	Elective II	PE	2	0	2	3
7	19EHS304	Universal Human Values: Understanding Harmony	HS	2	1	0	3
Total				**24**			
Industrial Project (6-8weeks)							

Semester VII

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB431	Usability Design of Software Applications	PC	2	0	1	2.5
2	19ECB433	IT Workshop Skylab / Mat lab	PC	1	0	4	3
3	19EID401	Financial Management	MS	2.5	0	0	2.5
4	19EID403	Human Resource Management	MS	2	0	0	2
5	19ECB4XX	Elective III	PE	2	1	2	4
6	19ECB45X	Elective IV	PE	2	1	2	4
7	19ECB491	Project Evaluation I	PW	0	0	2	1
Total				**19**			

Semester VIII

S.No.	Course Code	Course	Category	L	T	P	C
1	19EID432	Services Science & Service Ops Management	MS	3	0	2	4
2	19ECB432	IT Project Management	MS	3	0	2	4
3	19EID402	Marketing Research and Marketing Management	MS	2	0	0	2
4	19EXX46X	Elective V	PE	3	0	2	4
5	19EXX47X	Elective VI	PE	3	0	2	4
6	19ECB492	Project Evaluation II	PW	0	0	2	1
Total				**19**			

Total Credits 163

Total Number of Credits Semester Wise

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	20	20	20	21	24	19	19	**163**

Category wise and Credits distribution

Category	Category Code	Courses	Credits TCS	Credits proposed by AICTE
Humanities & Social Sciences	HS	Business Communication and Value Science I	**14**	**12**
		Business Communication and Value Science II		
		Fundamentals of Economics		
		Business Communication and Value Science III		
		Business Communication and Value Science IV		
		Universal Human Values: Understanding Harmony		
Basic Sciences	BS	Discrete Mathematics	**22**	**25**
		Probability & Statistics		
		Linear Algebra		
		Statistical Methods		
		Introduction to Statistics, Probability and Calculus		
		Physics for Computing Science		
Engineering Sciences	ES	Principles of Electrical Engineering	**12**	**24**
		Principles of Electronics Engineering		
		Introduction to Innovation, IP Management and Entrepreneurship		
		Design Thinking		
Management	MS	Operations Research	**23.5**	**18**
		Fundamentals of Management		
		Business Strategy		
		Financial & Cost Accounting		
		Financial Management		
		Human Resource Management		
		Services Science and Service Operational Management		
		IT Project Management		
		Marketing Research and Marketing Management		
Program Electives	PE	PE1-PE6	**23**	**18**
Program Core	PC	PC1-PC16	**65.5**	**48**
Project	PW	Mini Project	**3**	**15**
		Project Evaluation I		
		Project Evaluation II		
Mandatory	MC	Induction Program, Environmental Sciences, Constitution of India, Essence of Indian Traditional Knowledge	**-**	**-**
Total			**163**	**160**

PROGRAM ELECTIVES

Program Elective- I

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Digital Technologies	19ECB341	Conversational Systems	PE	2	1	2	4
2	Digital Technologies	19ECB343	Cloud, Micro services and Application	PE	2	1	2	4
3	Digital Technologies	19ECB345	Machine Learning	PE	2	1	2	4

Program Elective- II

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Digital Technologies	19ECB342	Robotics and Embedded Systems	PE	2	0	2	3
2	Digital Technologies	19ECB344	Modern Web Applications	PE	2	0	2	3
3	Data Science	19ECB346	Data Mining and Analytics	PE	2	0	2	3

Program Elective- III

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Digital Technologies	19ECB447	Cognitive Science and Analytics	PE	2	1	2	4
2	Digital Technologies	19ECB449	Introduction to IoT	PE	2	1	2	4
3	Data Science	19ECB451	Cryptology	PE	2	1	2	4

Program Elective- IV

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Computer Science	19ECB453	Quantum Computation and Quantum Information	PE	2	1	2	4
2	Data Science	19ECB455	Advanced Social, Text and Media Analytics	PE	2	1	2	4
3	Digital Technologies	19ECB457	Mobile Computing	PE	2	1	2	4

Program Elective- V

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Science and Humanities	19EHS440	Behavioral Economics	PE	3	0	2	4
2	Management	19EID450	Computational Finance and Modeling	PE	3	0	2	4
3	Science and Humanities	19EID452	Industrial Psychology	PE	3	0	2	4

Program Elective- VI

S.No.	Stream	Course Code	Course Title	Category	L	T	P	C
1	Digital Technologies	19ECB450	Enterprise Systems	PE	3	0	2	4
2	Management	19EID456	Advance Finance	PE	3	0	2	4
3	Digital Technologies	19ECB452	Image Processing and Pattern Recognition	PE	3	0	2	4

Semester I

S.No.	Course code	Course	Category	L	T	P	C
1	19EMA107	Discrete Mathematics	BS	3	1	0	4
2	19EMA109	Statistics, Probability and Calculus*	BS	3	0	0	3
3	19ECB131	Fundamentals of Computer Science	PC	3	0	4	5
4	19EEE133	Principles of Electrical Engineering	ES	2	0	2	3
5	19EPH137	Physics for Computing Science**	BS	2	0	2	3
6	19EHS101	Business Communication and Value Science I***	HS	1	0	2	2
7	19EMC183	Induction Program	MC	2	0	0	0
Total				**20**			

19EMA107: DISCRETE MATHEMATICS

L	T	P	C
3	1	0	4

This is designed exclusively for the branch of Computer Science and Business Systems to equip the students with the concepts of Calculus, Combinatorics and an analytic approach to abstract algebra. The calculus part covers evaluation of double, triple integrals and their applications. The later unit focuses on basics of modern algebra having applications in computer science.

Course objectives:

- To check the validity of arguments by using basic connective and valid rules of inference.
- To impart knowledge on basics of counting, solving recurrence relations.
- To teach Boolean algebra, basic properties, and Karnaugh's maps.
- To explain functions, relations and group theory.
- To know the nomenclature of graphs, isomorphism of graphs, paths, cycles circuits.
- To acquaint with the concept of trees, tree traversals, information storage and retrieval.

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UNIT I **10 L**

Logic: Propositional calculus - propositions and connectives, syntax; Semantics - truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of connectives; Equivalence and normal forms; Compactness and resolution; Formal reducibility - natural deduction system and axiom system; Soundness and completeness.

Learning Outcomes:

At the end of this unit, the student will be able to

- check the validity of the arguments with and without constructing truth tables and also by the rules of inference. (L4)
- to infer whether valid conclusions can be arrived by using valid rules of inference. (L2)

UNIT II **8 L**

Boolean Algebra: Introduction of Boolean algebra, truth table, basic logic gate, basic postulates of Boolean algebra, principle of duality, canonical form, Karnaugh map.

Learning Outcomes:

At the end of this unit, the student will be able to

- construct truth tables and draw logic gates. (L3)
- compute sum of products and product of sum expansions. (L3)
- make use of Karnaugh maps. (L3)

UNIT III **10 L**

Abstract Algebra: Set, relation, group, ring, field.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze basic operations of set theory and types of relations. (L4)
- identify Binary operation and algebraic structure. (L3)
- illustrate properties of algebraic structure. (L2)

UNIT IV **8 L**

Combinatorics: Basic counting, balls and bins problems, generating functions, recurrence relations. Proof techniques, principle of mathematical induction, pigeonhole principle.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze basic counting principles and proof techniques. (L4)
- solve recurrence relations. (L3)
- apply of pigeonhole principle. (L3)

UNIT V **10 L**

Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments, trees; Planar graphs, Euler's formula, dual of a planer graph, independence number and clique number, chromatic number, statement of Four-color theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- graph different properties of a graph, isomorphism of graphs, Eulerian, Hamiltonian paths cycles and circuit. Applications in determining planar graphs. (L3)
- apply the concepts of trees to find the tree traversals and minimal spanning trees. (L3)

Course Outcomes:

After completion of the course, the student will be able to

- check the validity of the arguments. (L5)
- analyses various proof techniques and application of principles. (L4)
- construct truth tables and optimize logic by maps. (L3)
- define various algebraic structures, axioms and properties. (L1)
- apply graph theory techniques to solve real life problems. (L3)

Text Book(s)

1. Trembly J.P. & Manohar, Discrete Mathematical Structures with applications to computer science, 1/e, McGraw Hill Education, 2017.
2. I. N. Herstein, Topics in Algebra, 2/e, John Wiley and Sons, 1975.
3. M. Morris Mano, Digital Logic & Computer Design, 1/e, Pearson, 2004.
4. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, 5/e, Macmillan Press, London, 1982.
5. L. Zhongwan, Mathematical Logic for Computer Science, World Scientific, Singapore, 1989.

References

1. Gilbert Strang, Introduction to linear algebra, 4/e, Wellesley-Cambridge Press, 2009.
2. R. A. Brualdi, Introductory Combinatorics, 1/e, North-Holland, New York, 1977.
3. N. Deo, Graph Theory with Applications to Engineering and Computer Science, 1/e, Prentice Hall, Englewood Cliffs, 2016.
4. E. Mendelsohn, Van-Nostrand, Introduction to Mathematical Logic, 4/e, Chapman & Hall, London, 1957.
5. C. L. Liu, Elements of Discrete Mathematics, 2/e, McGraw Hill, New Delhi, 2011.

19EMA109: STATISTICS, PROBABILITY AND CALCULUS

L	T	P	C
3	0	0	3

This course is designed to impart knowledge on the concepts of Data Science, fundamental properties of probability, distributions, correlation, regression, testing of hypothesis for sample and large samples in engineering applications.

Course objectives:

- To familiarize the students with the foundations of probability and statistical methods
- To impart probability concepts and statistical methods in various applications in Engineering
- To impart knowledge on basic concepts of calculus as these concepts lay a strong foundation in applications in Engineering.

UNIT I **8 L**

Probability: Concept of experiments, sample space, event. Definition of Combinatorial Probability. Conditional Probability, Baye's Theorem. Expected values and moments: mathematical expectation and its properties, Moments (including variance) and their properties, interpretation, Moment generating function.

Learning Outcomes:

At the end of this unit, the student will be able to

- define the terms events, sample space, probability, and laws of probability. (L1)
- make use of probabilities of events in finite sample spaces from experiments. (L3)
- apply Baye's theorem to real time problems. (L3)
- describe the characteristics of the frequency distributions by using mathematical expectation. (L2)

UNIT II **8 L**

Discrete Probability Distributions: Binomial, Poisson and Geometric distributions.

Learning Outcomes:

At the end of this unit, the student will be able to

- distinguish between the discrete and continuous probability distributions. (L4)
- describe the properties of discrete distribution functions. (L2)
- understand several well-known distributions, including binomial, poisson and geometrical. (L2)

UNIT III **8 L**

Continuous Probability Distributions: uniform, exponential, normal, chi-square, student - t and F distributions.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the properties of continuous distribution functions. (L2)
- understand several well-known distributions, including uniform, exponential, chi-square, Student – t and F distributions. (L2)
- interpret the properties of normal distribution and its applications. (L2)

UNIT IV **10 L**

Introduction to Statistics: Definition of Statistics. Basic objectives. Applications in various branches of science with examples. Collection of Data: Internal and external data, Primary and secondary Data. Population and sample, Representative sample. Descriptive Statistics: Classification and tabulation of univariate data, graphical representation, Frequency curves. Central tendency (Mean, Median and Mode) and dispersion (S.D, M.D, Q.D and Range). Bivariate data. Summarization, marginal and conditional frequency distribution.

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize the basic concepts of statistics and its importance in engineering. (L2)
- use appropriate statistical methods in the analysis of simple datasets. (L3)
- interpret and clearly present output from statistical analyses in a clear concise and understandable manner. (L5)
- analyze the data quantitatively or categorically, measure of averages, variability. (L4)

UNIT V **8 L**

Calculus: Basic concepts of Differential and integral calculus, application of double and triple integral.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply double integrals of functions of several variables in two dimensions in Cartesian and polar coordinates. (L3)
- calculate the areas bounded by a region using double integration techniques. (L3)
- apply multiple integrals in Cartesian, cylindrical and spherical geometries. (L3)
- evaluate volumes using triple integrals. (L5)

Course Outcomes:

After completion of the course, the student will be able to

- make use of the concepts of probability and their applications. (L3)
- apply discrete and continuous probability distributions. (L3)
- make use of the concepts of basic statistics and their applications. (L3)
- employ the tools of double integrals for calculating the areas. (L3)
- calculate volumes of solids by using triple integrals. (L3)

Text Book(s)

1. S.M. Ross,Introduction of Probability Models, 10/e, Academic Press, N.Y, 2010.
2. A. Goon, M. Gupta and B. Dasgupta, Fundamentals of Statistics, vol. I & II, 1/e, World Press, 2013.
3. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publication, Delhi, 1965.

References

1. S.M. Ross, A first course in Probability, 8/e, Prentice Hall, 2010.
2. I.R. Miller, J.E. Freund and R. Johnson, Probability and Statistics for Engineers, 9/e, PHI, 2017.
3. A.M. Mood, F.A. Graybilland D.C. Boes, Introduction to the Theory of Statistics, 3/e, McGraw Hill Education, 1973.
4. Peter V. O'Neil, Advanced Engineering Mathematics, 7/e, Thomson Learning, 2011.
5. M. D. Greenberg, Advanced Engineering Mathematics, 2/e, Pearson Education, 2002.
6. P. N. Wartikar and J. N. Wartikar, Applied Mathematics, Vol. I & II, Vidyarthi Prakashan.

19ECB131: FUNDAMENTALS OF COMPUTER SCIENCE

L	T	P	C
3	0	4	5

The course is designed to enable the student to develop logic and convert it into programs for problem solving. After the fundamentals of algorithms and flowcharts are introduced, the characteristics of imperative programming languages are taught with the C programming language. The course also lays down the foundation for working with the Unix operating system with basic file I/O and the make file utility.

Course objectives:

- Introduce the student to algorithm development for problem solving
- Familiarize the student with the modular approach to program design
- Acquaint the student with various programming constructs in C language
- Enable the student to convert logic into C language code
- Familiarize the student with basic operations on files in the Unix environment.

UNIT I **8 L**

General problem-solving concepts: Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

Imperative languages: Introduction to imperative language; syntax and constructs of a specific language (ANSI C)

Types Operator and Expressions with discussion of variable naming and Hungarian Notation: Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze a given problem. (L4)
- develop an algorithm to solve it. (L3)
- outline the structure of a C program and various key features of the C language. (L2)
- translate mathematical expressions to C notation using operators. (L2)

UNIT II **10 L**

Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, goto Labels, structured and unstructured programming

Functions and Program Structure with discussion on standard library: Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialization, Recursion, Preprocessor, Standard Library Functions and return types.

Learning Outcomes:

At the end of this unit, the student will be able to

- construct C programs using various conditional statements. (L3)
- develop C programs using loops and nested loops. (L3)
- experiment with the usage of functions and recursion. (L3)
- choose between various storage classes. (L3)

UNIT III **10 L**

Pointers and Arrays: Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array and Row/column major formats, Initialization of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated.

Learning Outcomes:

At the end of this unit, the student will be able to

- experiment with the usage of pointers. (L3)
- develop programs for storing and managing collections of items using arrays. (L3)
- utilize command line arguments for input to programs. (L3)

UNIT IV **8 L**

Structures: Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral Structures, Table look-up, Typedef, Unions, Bit-fields.

Input and Output: Standard I/O, Formatted Output – printf, formatted Input – scanf, Variable length argument list, file access including FILE structure, fopen, stdin, stdout and stderr, Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize structures and unions for creating collections of heterogeneous data types. (L3)
- compare the utilization of memory by structures and unions. (L5)
- make use of files and file operations to store and retrieve data. (L3)
- examine any C program for errors and eliminate them. (L4)

UNIT V **10 L**

Unix system Interface: File Descriptor, Low level I/O – read and write, Open, create, close and unlink, Random access – lseek, Discussions on Listing Directory, Storage allocator

Programming Method: Debugging, Macro, User Defined Header, User Defined Library Function, makefile utility.

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize low level file I/O operations. (L3)
- analyze storage allocation. (L4)
- experiment with macros, user defined library functions and headers. (L3)
- utilize the makefile utility of the Unix operating system. (L3)

Course Outcomes:

After completion of the course, the student will be able to

- build logic for solving a problem and translate it into a program. (L3)
- define variables and construct expressions using C language. (L1)
- utilize arrays, structures and unions for storing and manipulating data. (L3)
- develop and debug modular programs using functions. (L6)
- develop programs to store and retrieve data using files. (L6)
- construct macros, user-defined library functions and header files. (L3)

FUNDAMENTALS OF COMPUTER SCIENCE LABORATORY

List of Practical Experiments

1. a. Introducing Raptor tool for drawing flow charts for Problem Solving.
   b. Algorithm and flowcharts of small problems like GCD
2. Structured code writing with:
   a. Small but tricky codes
   b. Proper parameter passing
   c. Command line Arguments
   d. Variable parameter
   e. Pointer to functions
   f. User defined header
   g. Make file utility
   h. Multi file program and user defined libraries
   i. Interesting substring matching / searching programs
   j. Parsing related assignments

Text Book(s)

1. B. W. Kernighan and D. M. Ritchi, "The C Programming Language", 2/e, Prentice Hall, 1988.
2. B. Gottfried, "Programming in C", Schaum Outline Series, 2/e, McGraw-Hill Education, 1996.

References

1. Herbert Schildt, "C: The Complete Reference", 4/e, McGraw Hill, 2017.
2. Yashavant Kanetkar, "Let Us C", 15/e, BPB Publications, 2016.

19EEE133: PRINCIPLES OF ELECTRICAL ENGINEERING

L	T	P	C
2	0	2	3

This course introduces the student, the fundamentals of electrical engineering concepts needed for future courses to be learned. The first three units cover the electric circuit laws, theorems and electrical machines. The next two units cover the principles of Electro static and electromechanical conversions, measurement of electrical quantities, electrical safety and batteries.

Course objectives:

- Study the basic DC and AC networks used in electrical circuits.
- Study the basic concepts of electrical engineering.
- Demonstrate the concepts of electrical statics and electro-mechanics.
- Acquaint the knowledge about the measurement of electrical quantities.
- Demonstrate the concepts of electrical wiring and safety.

UNIT I **8 L**

Introduction: Concept of Potential difference, voltage, current, Fundamental linear passive and active elements to their functional current-voltage relation, voltage source and current sources, ideal and practical sources, concept of dependent and independent sources, Kirchhoff-s laws and applications to network solutions using mesh and nodal analysis, Concept of work, power and energy.

Learning Outcomes:

At the end of the unit, student will be able to

- state the basic terminologies used in electrical circuits. (L1)
- classify types of sources used in a electric circuit. (L1)
- predict the behavior of any electrical circuits. (L2)
- formulate and calculate the current, voltage and power in an electrical circuits. (L3)

UNIT II **6 L**

DC Circuits: Current-voltage relations of the electric network by mathematical equations to analyze the network (Thevenin's theorem, Norton's Theorem, Maximum Power Transfer theorem), Superposition theorem. Simplifications of networks using series-parallel, Star/Delta transformation.

Learning Outcomes:

At the end of the unit, student will be able to

- apply various techniques to analyze an electric circuit. (L3)
- state various network theorems. (L1)
- demonstrate the application of network theorems for the solution of circuits. (L3)
- apply various network reduction techniques to analyze an electric circuit. (L3)

UNIT III **6 L**

AC Circuits: AC waveform definitions, form factor, peak factor, study of R-L, R-C, RLC series circuit, R-L-C parallel circuit, phasor representation in polar and rectangular form, concept of impedance, admittance, active, reactive, apparent and complex power, power factor, solutions of 3 phase Balanced AC Circuits (Y-Δ&Y-Y).

Learning Outcomes:

At the end of the unit, student will be able to

- state various quantities used in AC circuits. (L1)
- estimate the response of R-L-C circuits for different configurations. (L6)
- describe the concept of impedance, admittance, real power and reactive power. (L2)
- derive various quantities in 3-phase balance AC circuits. (L4)

UNIT IV **8 L**

Electrostatics and Electro-Mechanics: Electrostatic field, electric field strength, concept of permittivity in dielectrics, capacitors, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors. Electricity and Magnetism: Magnetic material and B-H Curve, magnetic field and Faraday's law, self and mutual inductance, Ampere's law, Magnetic circuit, Single phase transformer, principle of operation, EMF equation, voltage ratio, current ratio, KVA rating, efficiency and regulation, Electromechanical energy conversion. Principle of batteries, types and application.

Learning Outcomes:

At the end of the unit, student will be able to

- state various quantities used in electrostatics and electro- magnetics. (L1)
- estimate the equivalent capacitance and energy stored in capacitor. (L6)
- describe charging and discharging of capacitors. (L2)
- describe the construction and working of transformers. (L2)
- illustrate Electromechanical energy conversion principles. (L4)
- state the principles of batteries and their applications. (L1)

UNIT V **8 L**

Measurements, Sensors and safety: Introduction to measuring devices/sensors and transducers (Piezoelectric and thermo-couple) related to electrical signals, Elementary methods for the measurement of single-phase power. Electrical Wiring: Basic layout of the distribution system, Types of Wiring System &Wiring Accessories, Necessity of earthing, Types of earthing, Safety devices & system.

Learning Outcomes:

At the end of the unit, student will be able to

- describe the measuring devices/sensors and transducers related to electrical signals(L2)
- demonstrate the methods of measurement of single-phase power. (L3)

- discuss about aspects of electrical safety and earthing. (L2)
- demonstrate Electrical distribution system, types of wiring. (L3)

Course Outcomes:

After successful completion of the course, the student will be able to

- predict and analyze the behavior of an electrical circuit. (L3)
- analyze the performance quantities such as losses, efficiency and identify applications of DC machines. (L4)
- explain the use of transformers in transmission and distribution of electric power and other applications. (L2)
- demonstrate the operation and applications of various electronic devices. (L2)

PRINCIPLES OF ELECTRICAL ENGINEERING LABORATORY

List of Practical Experiments

1. Familiarization of electrical Elements, sources, measuring devices and transducers related to electrical circuits
2. Determination of resistance temperature coefficient
3. Verification of Network Theorem (Superposition, Thevenin, Norton, Maximum Power
4. Transfer theorem)
5. Simulation of R-L-C series circuits for XL>XC, XL< XC
6. Simulation of Time response of RC circuit
7. Verification of relation in between voltage and current in three phase balanced star and delta connected loads.
8. Demonstration of measurement of electrical quantities in DC and AC systems.

Text Book(s)

1. A.E. Fitzgerald, Kingsely Jr Charles, D. Umans Stephen, Electric Machinery, 6/e, Tata McGraw Hill, 2003.
2. B. L. Theraja, A Textbook of Electrical Technology, (vol. I), 1/e, Chand and Company Ltd., New Delhi, 2005.
3. V. K. Mehta, Basic Electrical Engineering, 6/e, S. Chand and Company Ltd., New Delhi, 2012.
4. J. Nagrath and Kothari, Theory and problems of Basic Electrical Engineering, 2/e, Prentice Hall of India Pvt. Ltd., 2017.

References

1. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, 2/e, Oxford University Press, 2011.
2. D. J. Griffiths, Introduction to Electrodynamics, 4/e, Cambridge University Press, 2017.
3. William H. Hayt & Jack E. Kemmerly, Engineering Circuit Analysis, 8/e, McGraw-Hill Book Company Inc., 2013.
4. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, 1/e, Prentice Hall (India) Pvt. Ltd., 2004.

19EPH137: PHYSICS FOR COMPUTING SCIENCE
(w.e.f 2020-21 Admitted Batches)

L	T	P	C
2	0	2	3

This course aims to teach the fundamental principles guiding the most well-known phenomena in physics. Oscillations happen to be found in nearly every aspect of physical phenomena that are seen around us. Plenty of devices now rely on the propagation of light, quantum mechanics and solid state devices. They also make use of coherent light beams- LASERs as well as the study of transfer of heat energy in and across systems. This course will therefore provide a ground to understand and analyze many fundamental principles and phenomena involved in the operation and design of devices.

Course objectives:

- Teaches the fundamentals of oscillatory systems and the analogy of mechanical and electrical systems
- Explains the wave optics phenomena of interference, diffraction and polarization
- Delineates the fundamentals of quantum mechanics, crystallography and solid state physics
- Describes the fundamentals of lasers and few commonly used lasers
- Introduces the optical fibers and their applications
- Introduces the three laws of thermodynamics and their applications to a heat engine

UNIT I **8 L**

Oscillations: Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple spring-mass system, Resonance-definition, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators.

At the end of this unit, the student will be able to

- assess harmonic motion in undamped, damped as well as forced and damped oscillators. (L5)
- define and calculate resonance and quality factor. (L1)
- classify the types of damping. (L2)
- relate the analogy of mechanical and electrical oscillators. (L1)

UNIT II **10 L**

Wave Optics: Theory of interference fringes-types of Interference-Fresnel's prism-Newton's rings,

Diffraction-two kinds of diffraction-difference between interference and diffraction- Fraunhofer diffraction at single slit, plane diffraction grating; temporal and spatial coherence;

Polarization - concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster's law, double refraction.

Basic Idea of Electromagnetisms: Continuity equation for current densities, Maxwell's equation in vacuum and non-conducting medium.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the phenomenon of interference and diffraction. (L2)
- classify the types of interference and diffraction. (L2)
- explain and use experimental arrangements to exploit interference. (L2)
- explain the diffraction intensity profiles of single and multiple slits. (L2)
- explain the phenomenon of polarization. (L2)
- calculate the intensity profiles from the superposition of orthogonal linearly polarized waves. (L3)
- describe the phenomenon of double refraction. (L2)
- understand the concept of Electromagnetisms. (L2)

UNIT III **8 L**

Quantum Mechanics: Introduction - Planck's quantum theory- Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time-independent and time-dependent Schrödinger wave equation, physical significance of wave function, particle in a one dimensional potential box.

Crystallography: Basic terms-types of crystal systems, Bravais lattices, Miller indices, d-spacing, Atomic packing factor for SC, BCC, FCC and HCP structures, X-ray diffraction

Semiconductor Physics: Conductor, Semiconductor and Insulator; Origin of Band Theory Basic concept of Band theory.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the wave-particle duality and Heisenberg's uncertainty principle. (L2)
- calculate the wave functions and energy eigen values of a particle in a box. (L3)
- classify crystal systems and Bravais lattices. (L2)
- calculate the packing fractions for some common lattice types. (L3)
- distinguish conductors, semiconductors and insulators. (L2)
- explain energy bands in solids. (L2)

UNIT IV **5 L**

Lasers and Fiber Optics: Einstein's theory of matter-radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby, CO2 and Neodymium YAG (Neodymium-doped Yttrium Aluminum Garnet); properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering. Fiber optics and applications, types of optical fibers.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the phenomenon of stimulated emission and its use to produce laser beam. (L5)
- describe the working of some common laser systems. (L2)
- classify optical fibers. (L2)
- explain the applications of lasers and optical fibers. (L5)

UNIT V **6 L**

Thermodynamics: Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of first law, second law of thermodynamics and concept of engine, entropy, change in entropy in reversible and irreversible processes.

Learning Outcomes:
At the end of this unit, the student will be able to

- state and use the three laws of thermodynamics. (L1)
- apply the second law of thermodynamics to a heat engine. (L3)
- calculate the change in entropy for reversible and irreversible processes. (L5)

Course Outcomes:
After completion of the course, the student will be able to

- use the fundamentals of oscillatory systems and the analogy of mechanical and electrical systems. (L1)
- use interference, diffraction and polarization in optical systems. (L1)
- apply the fundamentals of quantum mechanics, crystallography and solid state physics. (L3)
- describe the working of a few commonly used lasers. (L2)
- classify optical fibers and describe their applications. (L2)
- use the three laws of thermodynamics and apply them to a heat engine. (L3)

PHYSICS FOR COMPUTING SCIENCE LABORATORY

List of Practical Experiments

1) Magnetic field along the axis of current carrying coil – Stewart and Gee
2) Determination of Hall coefficient of semi-conductor
3) Determination of Plank constant
4) Determination of wave length of light by Laser diffraction method
5) Determination of wave length of light by Newton's Ring method
6) Determination of laser and optical fiber parameters
7) Determination of Stefan's Constant.

Text Book(s)

1. A Beiser, Concepts of Modern Physics, 5/e, McGraw Hill International, 1995.
2. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 10/e, Wileyplus, 2013.

References

1. Ajoy Ghatak, Optics, 5/e, Tata McGraw Hill, 2012.
2. Sears & Zemansky University Physics, Addison-Wesley.
3. Jenkins and White, Fundamentals of Optics, 3/e, McGraw-Hill, 1957.

19EPH137: FUNDAMENTALS OF PHYSICS
(for 2019-20 Admitted Batch)

L	T	P	C
2	0	2	3

This course aims to teach the fundamental principles guiding the most well-known phenomena in physics. Oscillations happen to be found in nearly every aspect of physical phenomena that are seen around us. Plenty of devices now rely on the propagation of light, quantum mechanics and solid state devices. They also make use of coherent light beams- LASERs as well as the study of transfer of heat energy in and across systems. This course will therefore provide a ground to understand and analyze many fundamental principles and phenomena involved in the operation and design of devices.

Course objectives:

- Teaches the fundamentals of oscillatory systems and the analogy of mechanical and electrical systems
- Explains the wave optics phenomena of interference, diffraction and polarization
- Delineates the fundamentals of quantum mechanics, crystallography and solid state physics
- Describes the fundamentals of lasers and few commonly used lasers
- Introduces the optical fibers and their applications
- Introduces the three laws of thermodynamics and their applications to a heat engine

UNIT I **8 L**

Oscillations: Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple spring-mass system, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, forced oscillations and resonance in mechanical and electrical systems, quality factor.

Learning Outcomes:

At the end of this unit, the student will be able to

- assess harmonic motion in undamped, damped as well as forced and damped oscillators. (L5)
- define and calculate resonance and quality factor. (L1)
- classify the types of damping. (L2)
- relate the analogy of mechanical and electrical oscillators. (L1)

UNIT II **10 L**

Wave Optics: Theory of interference fringes-types of Interference-Fresnel's prism-Newton's rings,

Diffraction-two kinds of diffraction-difference between interference and diffraction- Fraunhofer diffraction at single slit, plane diffraction grating; temporal and spatial coherence;

Polarization - concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster's law, double refraction.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the phenomenon of interference and diffraction. (L2)
- classify the types of interference and diffraction. (L2)
- explain and use experimental arrangements to exploit interference. (L2)
- explain the diffraction intensity profiles of single and multiple slits. (L2)
- explain the phenomenon of polarization. (L2)
- calculate the intensity profiles from the superposition of orthogonal linearly polarized waves. (L3)
- describe the phenomenon of double refraction. (L2)

UNIT III **8 L**

Quantum Mechanics: Introduction - Planck's quantum theory- Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time-independent and time-dependent Schrödinger wave equation, physical significance of wave function, particle in a one dimensional potential well, Heisenberg picture.

Crystallography: Basic terms-types of crystal systems, Bravais lattices, Miller indices, d-spacing, Atomic packing factor for SC, BCC, FCC and HCP structures.

Solid State Physics: Conductor, Semiconductor and Insulator; Basic concept of Band theory.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the wave-particle duality and Heisenberg's uncertainty principle. (L2)
- calculate the wave functions and energy eigen values of a particle in a box. (L3)
- classify crystal systems and Bravais lattices. (L2)
- calculate the packing fractions for some common lattice types. (L3)
- distinguish conductors, semiconductors and insulators. (L2)
- explain energy bands in solids. (L2)

UNIT IV **5 L**

Lasers and Fiber Optics: Einstein's theory of matter-radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby, CO2 and Neodymium lasers; properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering. Fibre optics and applications, types of optical fibers.

Learning Outcomes:
At the end of this unit, the student will be able to

- explain the phenomenon of stimulated emission and its use to produce laser beam. (L5)
- describe the working of some common laser systems. (L2)
- classify optical fibers. (L2)
- explain the applications of lasers and optical fibers. (L5)

UNIT V **6 L**

Thermodynamics: Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of first law, second law of thermodynamics and concept of engine, entropy, change in entropy in reversible and irreversible processes, third law of thermodynamics.

Learning Outcomes:

At the end of this unit, the student will be able to

- state and use the three laws of thermodynamics. (L1)
- apply the second law of thermodynamics to a heat engine. (L3)
- calculate the change in entropy for reversible and irreversible processes. (L5)

Course Outcomes:

After completion of the course, the student will be able to

- use the fundamentals of oscillatory systems and the analogy of mechanical and electrical systems. (L1)
- use interference, diffraction and polarization in optical systems. (L1)
- apply the fundamentals of quantum mechanics, crystallography and solid state physics. (L3)
- describe the working of a few commonly used lasers. (L2)
- classify optical fibers and describe their applications. (L2)
- use the three laws of thermodynamics and apply them to a heat engine. (L3)

FUNDAMENTALS OF PHYSICS LABORATORY

List of Practical Experiments

1. To determine the thermal conductivity of a bad conductor by Lee's disc method
2. To determine refractive indices (o and e) of a bi-refringent material (Prism).
3. Magnetic field along the axis of current carrying coil – Stewart and Gee
4. To Study the Characteristics of PN Junction diode.
5. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle
6. To determine the energy gap of a semiconductor.
7. To calculate wavelengths of prominent lines using diffraction grating normal incidence.
8. Determination of wave length of light by Newton's rings method
9. To determine coefficient of damping and quality factor for damped simple harmonic motion of a simple pendulum.
10. Determination of Hall coefficient of semiconductor.
11. Determination of Plank constant.

Text Book(s)

1. A Beiser, Concepts of Modern Physics, 5/e, McGraw Hill International, 1995.
2. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 10/e, Wileyplus, 2013.

References

1. Ajoy Ghatak, Optics, 5/e, Tata McGraw Hill,2012.
2. Sears & Zemansky, University Physics, Addison-Wesley.
3. Jenkins and White, Fundamentals of Optics, 3/e,McGraw-Hill,1957.

19EHS101: BUSINESS COMMUNICATION AND VALUE SCIENCE I

L	T	P	C
1	0	2	2

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking / Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve their communication skills which are crucial in an academic environment as well as professional and personal lives. It aims to prepare students for careers requiring global business awareness and to develop skills required to work in internationally operating companies and organizations.

Course objectives:

- Understand what life skills are and their importance in leading a happy and well-adjusted life.
- Motivate students to look within and create a better version of self.
- Introduce them to key concepts of values, life skills and business communication.
- Overview of the course with immersion activity.
- Overview of biz communication.
- Self-awareness, confidence and communication.
- Essentials of Business communication.
- Application of communication skills.
- Application of Life Skills.
- Assignment.

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1		Understand	**Overview of LOL** (include activity on introducing self)	Lecture & reflection	1 hour

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Recognize the need for life skills and values		**Class activity** – presentation on favorite cricket captain in IPL and the skills and values they demonstrate	Activity	1 hour
			Self-work with immersion – interview a maid, watchman, sweeper, cab driver, beggar and narrate what you think are the values that drive them	Immersion activity	2 hours
			Overview of business communication	Lecture with videos	1 hour
			Activity: Write a newspaper report on an IPL match	Class activity with 3 iterations - Formative Evaluation	1 hour
			Activity: Record a conversation between a celebrity and an Interviewer	Class activity with 3 iterations - Formative Evaluation	1 hour
			Quiz Time	Summative Evaluation for Unit	30 mins
	Recognize own strengths and opportunities	Understand	**Self-awareness** – identity, body awareness, stress management	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours
2	Understand the basic tenets of communication Unit name: Be At Ease (BAE) (in Millennial lingo it means Before Anyone Else)	Understand	**Essential Grammar – I:** Refresher on Parts of Speech – Listen to an audio clip and note down the different parts of speech followed by discussion Tenses: Applications of tenses in Functional Grammar – Take a quiz and then discuss	Lecture with audio and video	1 hour

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Sentence formation (general & Technical), Common errors, Voices. Show sequence from film where a character uses wrong sentence structure (e.g. Zindagi Na Milegi Dobara where the characters use 'the' before every word)	Lecture with video/audio	1 hour
			Communication Skills: Overview of Communication Skills Barriers of communication, Effective communication		1 hour
			Types of communication- verbal and non – verbal – Role-play based learning **Importance of Questioning**	Activity based learning	1 hour
			Listening Skills: Law of nature- Importance of listening skills, Difference between listening and hearing, Types of listening.	Activity based learning	1 hour
	Recognize own strengths and opportunities	Understand	**Expressing self**, connecting with emotions, visualizing and experiencing purpose	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours
	Apply the basic communication practices in different types of communication	Apply	**Activity:** Skit based on communication skills	Formative Evaluation	4 hours
			Evaluation on Listening skills – listen to recording and answer questions based on them	Formative Evaluation	30 mins
3	Understand the basic tenets of communication	Understand	**Email writing**: Formal and informal emails, activity	Activity based learning	1 hour

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Talk Mail Write (TMW) - In Millennial it means **That Moment When**		**Verbal communication**: Pronunciation, clarity of speech	Audio and video based learning	30 minutes
			Vocabulary Enrichment: Exposure to words from General Service List (GSL) by West, Academic word list (AWL) technical specific terms related to the field of technology, phrases, idioms, significant abbreviations formal business vocabulary – Read Economic Times, Reader's Digest, National Geographic and take part in a GD, using the words you learnt/liked from the articles. Group discussion using words learnt	Activity based learning (Group Discussion) Flipped classroom where students will study words before coming to class	1 hour
			Practice: Toastmaster style Table Topics speech with evaluation	Activity based learning	2 hours over 2/3 days
			Written Communication: Summary writing, story writing	Activity based learning	1 hour
			Build your CV – start writing your comprehensive CV including every achievement in your life, no format, no page limit	Formative Evaluation	30 minutes
	Apply the basic communication practices in different types of communication	Apply	**Project:** Create a podcast on a topic that will interest college Students	Formative Evaluation	1 hour
	Recognize own strengths and opportunities	Understand	**Life skill:** Stress management, working with rhythm and balance, colours, and teamwork	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Apply the basic communication practices in different types of communication	Apply	**Project:** Create a musical using the learnings from unit	Formative Evaluation	2 hours
4	**Unit 4** Recognize the need for life skills and values Unit name: Realities of Facing Life (ROFL)	Understand	**Understanding Life Skills:** Movie based learning – **Pursuit of Happyness.** What are the skills and values you can identify, what can you relate to?	Interactive learning	3 hours
			Introduction to life skills What are the critical life skills	Activity and Video	1 hour
			Multiple Intelligences Embracing diversity – Activity on appreciation of diversity	Video and activity based	1 hour
	Apply the life skills to different situations	Apply	**Life skill:** Community service – work with an NGO and make a presentation	Field work: Formative Evaluation	10 hours
			Life skill: Join a trek – Values to be learned: Leadership, teamwork, dealing with ambiguity, managing stress, motivating people, creativity, result orientation	Field work: Formative Evaluation	12 hours
				TOTAL	**65 hours**

	Summative Evaluation	**Bloom's Level**	**Type of Assessment**	**Marks**	**Total**
		Understand	Knowledge Test	20 marks	**50 marks**
		Apply	Project (to be evaluated by TCS)	20 marks	
		Apply	Group discussion (to be evaluated by TCS)	10 marks	

Course Outcomes

After completion of the course, the student will be able to

- recognize the need for life skills and values: (L3)
- recognize own strengths and opportunities: (L3)
- apply the life skills to different situations: (L3)
- understand the basic tenets of communication: (L2)
- apply the basic communication practices in different types of communication: (L3)

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C1.6.1	Understand	Immersion (interview)	5
C1.6.2	Understand	Create Resume	4
C1.6.3	Apply	Group Assignment – community service	5
C1.6.4	Understand	Group activities	3
C1.6.5	Apply	Record a conversation	3
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand	Paper Trek followed by project		50
Apply			
Analyse			

Text Book(s)

1. There are no prescribed texts for Semester 1 – there will be handouts and reference links shared.

References

1. English vocabulary in use – Alan Mc'carthy and O'dell.
2. APAART: Speak Well 1 (English language and communication)
3. APAART: Speak Well 2 (Soft Skills)
4. Business Communication – Dr. Saroj Hiremath

Web References

1. Train your mind to perform under pressure- Simon sinek
   https://curiosity.com/videos/simon-sinek-on-training-your-mind-to-perform-under-pressure-capture-your-flag/
2. Brilliant way one CEO rallied his team in the middle of layoffs
   https://www.inc.com/video/simon-sinek-explains-why-you-should-put-people-before-numbers.html
3. Will Smith's Top Ten rules for success
   https://www.youtube.com/watch?v=bBsT9omTeh0

Online Resources

1. https://www.coursera.org/learn/learning-how-to-learn
2. https://www.coursera.org/specializations/effective-business-communication

Semester II

S.No.	Course Code	Course	Category	L	T	P	C
1	19EMA108	Linear Algebra	BS	3	1	0	4
2	19EMA110	Statistical Methods [$]	BS	3	1	0	4
3	19ECB132	Data Structures and Algorithms	PC	3	1	4	5
4	19EEC132	Principles of Electronics Engineering[$$]	ES	2	0	2	3
5	19EHS102	Fundamentals of Economics	HS	2	0	0	2
6	19EHS104	Business Communication and Value Science II	HS	2	0	0	2
7	19EMC182	Environmental Sciences (Non Credit)	MC	2	0	0	0
Total				**20**			

19EMA108: LINEAR ALGEBRA

L	T	P	C
3	1	0	4

This course is designed to gain knowledge in the concepts of Linear Algebra focusing on basics of matrices, matrix decomposition, vector spaces and singular value decomposition to understand the basic concepts of Linear Algebra in the applications of image processing and machine learning.

Course objectives:

- Familiarize with theory of matrices and tools for solving system of linear equations
- Impart knowledge on Eigen values and Eigen vectors.
- Teach basic concepts of vector spaces and their properties.
- Explain the concepts of inner product spaces.
- Familiarize with concept of singular value decomposition and its applications.

UNIT I **5 L**

Matrices I

Introduction to Matrices and Determinants, Cramer's rule, inverse of a matrix, rank of a matrix, solution of linear equations, solving system of linear equations, Gaussian elimination method, LU decomposition method, hermitian and unitary matrices.

Learning Outcomes:

After completing this Unit, students will be able to

- solve the system of linear equations. (L3)
- analyze lower and upper triangular matrices, Hermitian and Unitary matrices. (L4)

UNIT II **6 L**

Matrices-II

Linear Transformation, orthogonal transformation, vectors, linear dependence and independence, eigen values and eigen vectors, positive definite matrices.

Learning Outcomes:

After completing this Unit, students will be able to

- calculate Eigen values and Eigen vectors. (L3)
- examine the definiteness of the matrix. (L4)

UNIT III **6 L**

Vector Spaces: vector space, linear combination of vectors, linear span, basis and dimension. Linear transformations-null space, kernel, range space, rank and nullity.

Learning Outcomes:

After completing this Unit, students will be able to

- examine whether a set of vectors form a basis. (L4)
- analyze properties of a linear transformations. (L4)
- understand the properties of rank and nullity. (L2)

UNIT IV **5 L**

Inner Product Spaces, examples of inner product spaces, cauchy-schwarz's inequality, orthogonality, orthogonal sets and bases gram schmidt orthogonalization process.

Learning Outcomes:

After completing this Unit, students will be able to

- understand an inner product. (L2)
- apply Cauchy-Schwartz's inequality. (L3)
- construct ortho normal basis. (L3)

UNIT V **7 L**

singular value decomposition and principal component analysis, introduction to image processing and machine learning.

Learning Outcomes:

After completing this Unit, students will be able to

- experiment singular value decomposition in Image processing. (L3)
- understand singular value decomposition and principal Component analysis. (L2)

Note: Assignments & tutorials covering the following: Vectors and linear combinations, Matrices, Linear transformations, Complete solution to Ax = b, Determinants, Eigenvalues and Eigenvectors

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics,44/e, Khanna Publishers, 1965.

Reference Books:

1. Peter V. O'Neil, Advanced Engineering Mathematics, 7/e, Cengage, 2012.
2. Michael. D. Greenberg, Advanced Engineering Mathematics, 2/e, Pearson,2002.
3. Gilbert Strang, Introduction to linear algebra, 5/e, Wellesley-Cambridge Press, 2016.
4. P. N. Wartikar& J. N. Wartikar,Applied Mathematics (Vol. I & II).
5. R C Gonzalez and R E Woods, Digital Image Processing,3/e, Pearson,2012.
6. https://machinelearningmastery.com/introduction-matrices-machine-learning
7. Seymour Lipchutz, Marc Lipson, Linear Algebra, Schaum's Outline,4/e, McGraw-Hill Education, 2008

Course Outcomes:

At the end of the course the student will be able to

- solve the system of linear equations. (L3)
- calculate Eigen values and Eigen vectors. (L3)
- understand the properties of rank and nullity. (L2)
- construct ortho normal basis. (L6)
- learn and manage Singular value decomposition and Principal Component Analysis in Machine learning. (L5)

19EMA110: STATISTICAL METHODS

L	T	P	C
3	1	0	4

The statistical modeling represents the collection of data and summarize the data for further interpretation. It describes a set of probability distribution, correlation, regression, time series analysis and other statistical analyses which are necessary for analyzing the collected data and information on the basis of statistical tools. The thrust of the course is to prepare students to enter into a promising professional life even after graduation, as also provide to them a platform to convert as a data analyst.

Course objectives:

- Familiarize the students with the foundations of statistical modeling techniques.
- Sensitize the students will obtain knowledge about the basic concepts of nonparametric statistical inference.
- Learn how to perform hypothesis testing for population proportion by the *p*-value approach
- Distinguish ARIMA terms from simultaneously exploring an ACF and PACF
- Import, review, manipulate and summarize data-sets in R.

UNIT I **8 L**

Linear Statistical Models, Estimation and Sufficient Statistic:

Simple linear regression & correlation, multiple regression & multiple correlation, Analysis of variance (one way, two way with as well as without interaction), **Estimation**: Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation, **Sufficient Statistic**: Concept & examples, complete sufficiency, their application in estimation.

Learning Outcomes:

At the end of this unit, the student will be able to

- use the equation of a linear function to model a data set. (L3)
- apply their knowledge of linear model to solve real world problems in comparing two measurement data. (L3)
- approximate the value of a population parameter on the basis of a sample statistic. (L4)
- learn a formal definition of sufficiency. (L1)
- learn how to apply the Factorization Theorem to identify a sufficient statistic. (L3)

UNIT II **10 L**

Test of hypothesis: Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing (single proportion and mean, double proportions and Means for Large Samples, t-test, F-test and Chi-Square tests for Small samples).

Learning Outcomes:

At the end of this unit, the student will be able to

- understand how to develop Null and Alternative Hypotheses. (L3)
- understand Type I and Type II Errors. (L2)
- learn how to perform hypothesis testing for population proportion by the *p*-value approach. (L4)
- use confidence interval to draw conclusion about two-sided test. (L5).

UNIT III **8 L**

Non-parametric Inference: Comparison with parametric inference, Use of order statistics. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test. Tolerance region.

Learning Outcomes:

At the end of this unit, the student will be able to

- find the differences among parametric, nonparametric and semi-parametric inferences. (L2)
- learn nonparametric procedures for analyzing real data. (L4)
- perform and interpret the Mann Whitney U Test, Run test, Kolmogorov-Smirnov test, Spearman's and Kendall's test. (L2)
- identify the appropriate nonparametric hypothesis testing procedure based on type of outcome variable and number of samples. (L4)

UNIT IV **8 L**

Basics of Time Series Analysis & Forecasting: Stationary, ARIMA Models: Identification, Estimation and Forecasting.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify and interpret a non-seasonal ARIMA model. (L4)
- distinguish ARIMA terms from simultaneously exploring an ACF and PACF. (L5)
- test that all residual autocorrelations are zero. (L4)
- convert ARIMA models to infinite order Moving Average models. (L4)
- forecast with ARIMA models. (L5)

UNIT V **10 L**

R statistical programming language: Introduction to R, Functions, Control flow and Loops, Working with Vectors and Matrices, Reading in Data, Writing Data, Working with Data, Manipulating Data, Simulation, Linear model, Data Frame, Graphics in R.

Learning Outcomes:

At the end of this unit, the student will be able to

- motivate for learning a programming language. (L3)
- access online resources for R and import new function packages into the R workspace. (L4)
- import, review, manipulate and summarize data-sets in R. (L4)
- explore data-sets to create testable hypotheses and identify appropriate statistical tests using R. (L5)
- create and edit visualizations with R. (L4)

Text Books:

1. I.R. Miller, J.E. Freund and R. Johnson, Probability and Statistics for Engineers, 4/e.
2. A. Goon, M. Gupta and B.Dasgupta, Fundamentals of Statistics (Vol. I & Vol. II).
3. Chris Chatfield, The Analysis of Time Series: An Introduction.

Reference Books:

1. D.C. Montgomery &E.Peck ,Introduction to Linear Regression Analysis,3/e, Wiley India Pvt. Ltd,2006.
2. A.M. Mood, F.A. Graybill & D.C. Boes, Introduction to the Theory of Statistics,3/e ,McGraw Hill Education,1 July 2017.
3. N. Draper & H. Smith, Applied Regression Analysis,3/e, Wiley India Private Limited.
4. Garrett Grolemund , Hands-on Programming with R,1/e, O'reilly media,2014.
5. Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, 2/e, Pearson Education,2018.

Data Source:

- www.rbi.org.in

Course Outcomes:

After completion of the course, the student will be able to

- use the equation of a linear function to model a data set. (L3)
- understand how to develop Null and Alternative Hypotheses. (L2)
- find the differences among parametric and nonparametric inferences. (L2)
- identify and interpret a non-seasonal ARIMA model. (L4)
- import, review, manipulate and summarize data-sets in R. (L4)

19ECB132: DATA STRUCTURES AND ALGORITHMS

L	T	P	C
3	1	4	5

This course introduces the student data structures and analysis of algorithms. Organizing and retrieving data using various linear and non-linear data structures is taught. The most commonly used searching and sorting algorithms are discussed, along with their time and memory complexities. Basic hashing and file organization are introduced as well.

Course objectives:

- Familiarize the student with various linear and non-linear data structures.
- Enable the student to analyze a given algorithm in terms of its time and space complexities.
- Familiarize the student with basic searching and sorting techniques.
- Introduce hashing for data storage and retrieval.
- Introduce basic types of file organization.

UNIT I **8 L**

Basic Terminologies & Introduction to Algorithm and Data Organization: Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, Refinement of Coding - Time-Space Trade Off, Testing, Data Abstraction.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the Big-O, Omega and Theta notations. (L2)
- analyze an algorithm in terms of its space and time complexities. (L4)
- improve code by reducing its complexity. (L6)

UNIT II **8 L**

Linear Data Structure: Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures.

Learning Outcomes:

At the end of this unit, the student will be able to

- construct stacks, queues and linked lists using different representations. (L3)
- demonstrate various operations on stacks, queues and linked lists. (L2)
- analyze the complexity of various operations on these data structures. (L4)

UNIT III **8 L**

Non-linear Data Structure: Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree) and Graphs (Directed, Undirected), Various Representations, Operations (search and traversal algorithms and complexity analysis) & Applications of Non-Linear Data Structures.

Learning Outcomes:

At the end of this unit, the student will be able to

- organize data using different types of trees and graphs. (L3)
- illustrate various operations such as insertion, deletion and traversal on trees and graphs. (L3)
- analyze the various representations of and operations on trees and graphs in terms of space and time .(L4)

UNIT IV **8 L**

Searching and Sorting on Various Data Structures: Sequential Search, Binary Search, Breadth First Search, Depth First Search, Insertion Sort, Selection Sort, Shell Sort, Divide and Conquer Sort, Merge Sort, Quick Sort, Heap Sort.

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize various searching algorithms to search for data. (L3)
- apply sorting techniques to sort data. (L3)
- analyze the performance of different searching and sorting techniques in terms of space and time .(L4)

UNIT V **10 L**

Introduction to Hashing: File: Organization (Sequential, Direct, Indexed Sequential, Hashed) and various types of accessing schemes.

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize hashing for efficient storage and retrieval of data. (L3)
- interpret various file organizations. (L2)
- compare different kinds of file organizations and accessing schemes. (L4)

DATA STRUCTURES & ALGORITHMS LABORATORY

List of Practical Experiments:

1. Towers of Hanoi using user defined stacks.

2. Reading, writing, and addition of polynomials.

3. Line editors with line count, word count showing on the screen.

4. Trees with all operations.

5. All graph algorithms.

6. Saving / retrieving non-linear data structure in/from a file

Text Book(s)

1. E. Horowitz and S. Sahni , Fundamentals of Data Structures, 1977.

2. Alfred V. Aho, John E. Hopperoft, Jeffrey D. UIlman, Data Structures and Algorithms, 1/e, Pearson, 1983.

References

1. Donald E. Knuth, The Art of Computer Programming: Volume 1: Fundamental Algorithms, 3/e, Addison-Wesley Professional, 1997.

2. Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 3/e,The MIT Press, 2009.

3. Pat Morin , Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31/e ,UBC Press, 2013.

Course Outcomes:

After the completion of this course, the student will be able to

- describe various linear and non-linear data structures. (L2)
- analyze these data structures in terms of their complexity. (L4)
- select a suitable data structure for a given application. (L4)
- discuss various hashing, searching and sorting techniques. (L2)
- select a hashing, searching or sorting algorithm for a given application. (L4)
- develop programs to store, sort and retrieve data using different types of data structures, searching and sorting techniques. (L6)

19EEC132: PRINCIPLES OF ELECTRONICS ENGINEERING

L	T	P	C
2	0	2	3

The course is about basic electronic circuits, principles of both analog and digital circuits. In the analog part, basic semiconductor theory, diode circuits, BJT amplifiers, MOSFET and Op-Amp circuits will be covered. In the digital part, combinatorial and sequential circuits will be covered. The course is designed in order to give a realistic picture of the circuit design, analysis and circuit operation.

Course objectives:

- Familiarize with basic semiconductor physics and devices
- Impart knowledge on application of semiconductor devices.
- Explain the concepts of BJT and MOSFET and then to design basic circuits like amplifiers
- Explain the concepts of feedback amplifiers and applications of Operational amplifiers.
- Introduce digital electronics and to familiarize the design of combinational and sequential circuits.

UNIT I **5 L**

Semiconductors: Crystalline material: Mechanical properties, Energy band theory, Fermi levels; Conductors, Semiconductors & Insulators: electrical properties, band diagrams. Semiconductors: intrinsic & extrinsic, energy band diagram, P&N-type semiconductors, drift & diffusion carriers.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand energy band structures of semiconductors and importance of semiconductors. (L1)
- need of doping, P-type and N-type semiconductor structure and their carrier concentrations. (L1)

UNIT II **6 L**

Diodes and Diode Circuits: Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance. Linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

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Learning Outcomes:

At the end of this unit, the student will be able to

- understand the characteristics of P-N diode, Zener diode. (L2)
- design and analyze rectifier circuits needed for regulation. (L3)

UNIT III **6 L**

Bipolar Junction Transistors: Formation of PNP / NPN junctions; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, injection efficiency, base transport factor and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor

Field Effect Transistors: Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD configurations; CMOS: Basic Principles

Learning Outcomes:
At the end of this unit, the student will be able to

- understand the structure and operation of BJT, MOSFET and CMOS. (L4)
- analyze the behavior of these devices under different bias conditions. (L5)
- distinguish various configurations of BJT and MOSFET. (L4)
- design few circuits like amplifier with these bipolar and MOS devices. (L5)

UNIT IV **5 L**

Feed Back Amplifier, and Operational Amplifiers: Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability. Introduction to integrated circuits, operational amplified and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant-gain multiplier, Voltage follower, Comparator, Integrator, Differentiator

Learning Outcomes:
At the end of this unit, the student will be able to

- understand the concept of feedback and various configurations of feedback amplifiers. (L2)
- analyze the characteristics and configurations of Op-amp. (L4)
- design various circuits using Op-amp. (L6)

UNIT V **7 L**

Digital Electronics Fundamentals: Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters

Learning Outcomes:
At the end of this unit, the student will be able to

- understand various methods for Boolean function minimization. (L2)
- design and analyze different combinational and sequential circuits. (L6)

PRINCIPLES OF ELECTRONICS ENGINEERING LAB

1. Semiconductor Diodes and application,
2. Transistor circuits,
3. JFET and amplifiers.
4. Digital Logic Gates.

Text Books:

1. Adel S. Sedra and Kenneth Carless Smith , Microelectronics Circuits,7/e, Oxford University Press,2017.
2. Jacob Millman, Christos Halkias, Chetan Parikh , Millman's Integrated Electronics,2/e, McGraw Hill Education,1 July 2017.
3. M. Morris Mano , Digital Logic & Computer Design,1/e, Pearson Education India,30 June 2016.

Reference Books:

1. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 10/e, Pearson, 2009.
2. Ben Streetman, Sanjay Banerjee, Solid State Electronic Devices, 7/e, Pearson Education India, 2015.
3. Albert Paul Malvino , Electronic Principle.
4. D Schilling, C Belove, T Apelewicz, R Saccardi , Electronics Circuits: Discrete & Integrated,3/e, McGraw-Hill Education,2002.
5. Jacob Millman, Arvin Grabel , Microelectronics,2/e, McGraw Hill Education,2017.
6. S. Salivahanan, N. Suresh Kumar, A. Vallavaraj , Electronics Devices & Circuits, McGraw Hill Education,2007.
7. Robert L. Boylestad, Louis Nashelsky , Electronic Devices & Circuit Theory, 11/e, Pearson Education India, 2015.

Course Outcomes:

At the end of the course the student will be able to

- understand energy band structures of semiconductors and importance of semiconductors need of doping P-type and N-type semiconductors structure and their carrier concentrations. (L2)
- understand the characteristics of P-N diode, Zener diode. (L2)
- design and analyze rectifier circuits needed for regulation. (L6)
- understand the structure and operation of BJT, MOSFET and CMOS and analyze the behavior of these devices under different bias conditions. (L4)
- distinguish various configurations of BJT and MOSFET and design few circuits like amplifier with these bipolar and MOS devices. (L5)
- understand the concept of feedback and various configurations of feedback amplifiers. (L2)
- analyze the characteristics and configurations of Op-amp and design various circuits using Op-amp . (L4)
- understand various methods for Boolean function minimization. (L2)
- design and analyze different combinational and sequential circuits. (L6)

19EHS102: FUNDAMENTALS OF ECONOMICS

L	T	P	C
2	0	0	2

The course is designed to introduce to the students the basic concepts of economics keeping in view the inter-linkages between business and economics. It involves imparting basic knowledge on fundamentals of economics, specifically, Microeconomics and Macroeconomics. This course is a prerequisite to understanding and analyzing working of consumer and producer behaviour at an individual unit (Micro) level, and understanding of working of forces of economy at national (Macro) level.

Course objectives:

- Introduce various basic concepts and terminology of the subject of economics.
- Acquaint the nuances of optimizing conditions of consumer and producer behaviour.
- Understand various features concepts used in macroeconomic decision-making.
- Acquiring basic knowledge of monetary and fiscal policy and external sector economics
- Understand role of government in economic decision making at microeconomic and macroeconomic level.

UNIT I **5 L**

Principles of Demand and Supply — Supply Curves of Firms — Elasticity of Supply; Demand Curves of Households — Elasticity of Demand; Equilibrium and Comparative Statics (Shift of a Curve and Movement along the Curve)

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the basis of behaviour of consumer and producer. (L2)
- understand elasticity concept. (L2)
- determinants of demand and supply and responsiveness to changes in them. (L3)

UNIT II **5 L**

Welfare Analysis — Consumers' and Producers' Surplus — Price Ceilings and Price Floors; Consumer Behaviour — Axioms of Choice — Budget Constraints and Indifference Curves; Consumer's Equilibrium — Effects of a Price Change, Income and Substitution Effects —Derivation of a Demand Curve.

Learning Outcomes:

At the end of this unit, the student will be able to

- learn consumer optimisation equilibrium. (L2)
- learn impact of government measures on consumer equilibrium. (L2)
- learn effect of government intervention on welfare of consumers and producers. (L2)

UNIT III **6 L**

Applications — Tax and Subsidies — Inter-temporal Consumption — Suppliers' Income Effect; Theory of Production — Production Function and Iso-quants — Cost Minimization; Cost Curves — Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm under Perfect Competition; Monopoly and Monopolistic Competition.

Learning Outcomes:
At the end of this unit, the student will be able to

- learn producer optimisation decisions. (L2)
- learn various markets. (L2)
- learn impact of government intervention on producer behaviour. (L3)

UNIT IV **6 L**

National Income and its Components — GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector — Taxes and Subsidies;

Learning Outcomes:
At the end of this unit, the student will be able to

- learn various indicators of national income. (L4)
- learn basic models of national income and employment determination. (L4)
- learn the role of government in national income determination. (L5)

UNIT V **7 L**

External Sector — Exports and Imports; Money — Definitions; Demand for Money —Transactionary and Speculative Demand; Supply of Money — Bank's Credit Creation Multiplier; Integrating Money and Commodity Markets — IS, LM Model; Business Cycles and Stabilization — Monetary and Fiscal Policy — Central Bank and the Government; The Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment.

Learning Outcomes:
At the end of this unit, the student will be able to

- get insights into concepts of exports and imports. (L1)
- do detailed analysis of money and commodity markets in the economy. (L4)
- role of central bank and government in managing the economy. (L5)
- role of prices and wages in income and employment determination. (L4)

Text Books:

1. Pindyck, Robert S., and Daniel L. Rubinfeld , Microeconomics,7/e, Pearson,2009.
2. Dornbusch, Fischer and Startz , Macroeconomics, 12/e, McGraw Hill Education,27 August 2018.
3. Paul Anthony Samuelson, William D. Nordhaus, Economics,20/e, McGraw-Hill, 28 October 2019.

Reference Books:

1. Intermediate Microeconomics: A Modern Approach, Hal R, Varian.
2. Principles of Macroeconomics, N. Gregory Mankiw.

Course Outcomes:

At the end of the course, the student will be able to

- have a basic knowledge of terminology and fundamental concepts of economics. (L1)
- have a sound understanding of decision making behaviour of consumers. (L2)
- get a detailed insightful knowledge of producer optimisation conditions and equilibrium. (L3)
- analyse the critical role played by various variables in determination of macroeconomic aggregates. (L4)
- demonstrate substantial understanding of the role played by policy making in determining various outcomes in an economy. (L2)

19EHS104: BUSINESS COMMUNICATION & VALUE SCIENCE II

L	T	P	C
2	0	0	2

Pre requisites: Basic Knowledge of English (verbal and written) Completion of all units from Semester 1

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking / Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve their communication skills which are crucial in an academic environment as well as professional and personal lives. It aims to prepare students for careers requiring global business awareness and to develop skills required to work in internationally operating companies and organizations.

Course objectives:

- Develop effective writing, reading, presentation and group discussion skills. Motivate students to look within and create a better version of self.
- Help students identify personality traits and evolve as a better team player.
- Introduce them to key concepts of Morality, Behavior and beliefs and Diversity & Inclusion
- Identification of common errors in written communication and ways of rectification
- Understanding speed reading techniques – Skimming and Scanning
- Application of reading and writing skills
- Analyzing personality traits and team player style
- Understanding the concepts of Morality, Diversity and Inclusion
- Application of these concepts
- Creation of communication material
- Experiencing diversity and organizing events to support inclusion

Assignment – Assimilation of concepts and present them effectively

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 3 Hrs. / Week	**Semester Examination Marks: 50**	**2**
Practical: 7 Hrs. / Week	**Continous Assessment: Yes**	
Lab: 7 Hrs. / Week	**Term Work: 50 Marks**	

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1			Icebreaker. 1) Participate in 'Join Hands Movement'. Individual identification of social issues.2) Each Individual chooses one particular social issue which they would like to address. 3) Class to be divided in teams for the entire semester. All activities to be done in teams and the grades, credit points will be captured in the leader board in the class room.4) Theory to introduce the participant Slam book to be used for capturing individual learning points and observations.	Group discussion, Practical	60 Minutes
1	Understand tools of structured written communicatio n	Understand	Research on the social cause each group will work for.	Practical (practical)	90 Minutes
1	Use tools of structured written communicatio n	Understand	Class discussion- Good and Bad Writing. Common errors, punctuation rules, use of words.	PPT, Theory and Practical	90 Minutes
1			**Group Practical** – As a group, they will work on the social issue identified by them. Research, read and generate a report based on the findings. (Apply the learning and recap from the session)	Formative evaluation	70 Minutes
			Practical: Plan and design an E Magazine. Apply and		

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Create communication material to share concepts and ideas	Create	assimilate the knowledge gathered from Sem-1 till date. Share objective & guideline. All members to contribute an article to the magazine, trainer to evaluate the content.	Practical (Practical)	120 Minutes
1	Understand tools for Lucid writing	Understand	Lucid Writing: Encourage the students to go through the links given about Catherine Morris and Joanie Mcmahon's writing techniques.	Theory and Discussion	30 mins
1	Create communication material to share concepts and ideas	Create	Create the magazine	Practical (Lab)	90 Minutes
1		Understand	SATORI – Participants share the personal take away acquired from GD, writing and reading skills activities captured in their handbook. Share the most important learning points from the activities done so far and how that learning has brought a change.	Theory/Discussion	60 Minutes
1	Use electronic/social media to share concepts and ideas	Apply	Launching an E Magazine.	Practical (Lab)	120 Minutes
1			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 2					

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
2	Develop materials to create an identity for an organization dedicated to a social cause	Create	Each group will form an NGO. Create Vision, Mission, Value statement, tagline and Design a logo.	Practical and Practical	90 Minutes
2	Understand the basics of presentation	Understand	Introduction to basic presentation skills & ORAI app	Theory and video	60 Minutes
2	Apply effective techniques to make presentations.	Apply	Groups to present their NGOs. Apply the learning gathered from session 2. Presentation to be recorded by the groups. feedback from the audience/ Professor	Formative evaluation	60 Minutes
2	Assess presentation based on given criteria	Evaluate	Group to come back and share their findings from the recording. Post work- individual write up to be written and evaluated for the E- magazine	Sharing of learning, written Practical and formative evaluation	60 Minutes & 60 Minutes
2	Create communication material to share concepts and ideas Use electronic/social media to share concepts and ideas	Create Apply	Prepare and publish the Second episode of the E Magazine.	Practical (Lab)	120 minutes
2	Understand the tools for speed reading.	Understand Apply	Speed Reading session: Introduction to skimming and scanning; practice the same.	Theory and Practical	30 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Apply the basic concepts of speed reading, skimming and scanning.				
2		Understand	SATORI – Join the dots- Participants to connect their learning gathered from AIP Unit-2 with their existing curriculum	Share the most important learning points	60 Minutes
2			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 3					
3	Develop materials to create an identity for an organization dedicated to a social cause	Create	Ad campaign- Brain storming session- Students to discuss and explore the means of articulating and amplifying the social issue their NGOs are working for.	Discussion	60 Minutes
3	Create communication material to share concepts and ideas.	Create	Design a skit- a) write the script articulating the message of their respective NGOs. Read out the script. (Skit time- 5 minutes). Feedback of Theory.	Practical based learning. Formative evaluation by Theory	a) 30 Minutes b) 60 Minutes
3	Use electronic/social media to share concepts and ideas	Apply	Promote the play through a social media and gather your audience. Enact the play. Capture the numbers of likes and reviews. Theory to assign grades to individual team.	Practical based learning Formative Evaluation	Lab Time: 90 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
					Class Time:60 Minutes
3	Identify individual personality types and role in a team.	Understand	(1) Theory to find out from the participants their views, observations and experiences of working in a team(2) Intro of Dr. Meredith Belbin and his research on team work and how individuals contribute.	Discussion and Theory	60 Minutes
3	Identify individual personality types and role in a team.	Understand	Cont. (3) Belbin's 8 Team Roles and Lindgren's Big 5 personality traits.(4) Belbin's 8 team player styles	Practical based learning followed by a presentation	40 Minutes
3	Identify individual personality types and role in a team.	Understand	(1) Team Falcon Practical to identify individual personality traits with Belbin's 8 team player styles	Practical based learning followed by a presentation.	(1 &2) 40 Minutes
3	Recognize the concepts of outward behavior and internal behavior	Understand	(2) Similar personality types to form groups (3) Groups present their traits.	Presentation	(3) 60 minutes
3	Create communicatio n material to share concepts and ideas.	Create Apply	Prepare and publish the third episode of the E Magazine.	Practical	60 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Use the electronic/social media to share concepts and ideas				
3		Understand Understand	SATORI – (join the dots with participants personal life) Participants share the personal take away acquired from working in teams, GD, learning about presentations, presenting their NGOs	Share the most important learning points from the activities done so far. Participants talk about the changes they perceive in themselves	60 Minutes
3			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 4					
4	Understand the basic concepts of Morality and Diversity	Understand	Ten minutes of your time – a short film on diversity. Play the video (link to be attached in the FG)	Video & discussion	30 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Discuss key take away of the film. Theory to connect the key take away of the film to the concept of empathy.	Practical	30 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Touch the target (Blind man) - Debriefing of the Practical. Film: "The fish and I'' by Babak Habibifar" (1.37mins)	Practical and discussion	60 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
4	Create communication material to share concepts.	Create	Groups to create a story – 10 minutes of a person's life affected by the social issue groups are working on. Narrate the story in first person. Feedbacks to be shared by the other groups.	Practical, sharing and Practical	120 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Research on a book, incident or film based on the topic of your respective NGO	Research and written Practical	120 Minutes
4	Create communication material to share concepts.	Create	Write a review in a blog on the topics they are covering in their research. Theory will give grades to each team.	Written Practical and Formative Evaluation	60 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Session on Diversity & Inclusion- Different forms of Diversity in our society.	PPT, Theory, discussion	60 Minutes
4	Create communication material to share concepts.	Create	Teams to video record interviews of people from diverse groups (Ask 5 questions). Share the recordings in FB	Practical	120 Minutes
4	Argue on a topic based on morality and diversity	Evaluate	Debate on the topic of diversity with an angle of ethics, morality and respect for individual (In the presence of an external moderator). Groups will be graded by the professor.	Practical and formative evaluation	60 Minutes
4	Articulate opinions on a topic with the objective of	Create	Prepared speech- Every student will narrate the challenges faced by a member of a diverse group in 4	Practical and formative Evaluation	90 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	influencing others		minutes (speech in first person). Theory to give feedback to each student.		
4	Understand the basic concepts of Morality and Diversity	Understand	Discussion on TCS values, Respect for Individual and Integrity.	PPT, Theory, Practical and discussion	60 Minutes
4	Create communication material to share concepts and ideas. Use the electronic/social media to share concepts and ideas	Create Apply	Prepare and publish the final episode of the E Magazine.	Practical	120 Minutes
4		Understand	SATORI –Participants share the personal take away acquired from working in teams, GD, learning about presentations and understanding diversity inclusion.	Discussion	60 Minutes
4	Use tools of structured written communication	Apply	**Revisit your resume** Include your recent achievements in your resume.	Submit it to the Professor	Lab time-30 Minutes
4			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
4	Organize an event to generate awareness and	Create	**Project-** 1) Each team to look for an NGO/ social group in the city which is working on the issue their college group is supporting. 2) Spend **a day with the**	Field work: Formative Evaluation	7 Hours

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	get support for a cause		**NGO/ social group** to understand exactly how they work and the challenges they face. 3) Render voluntary service to the group for one day 4) Invite the NGO/ social group to address their university students for couple of hours. Plan the entire event, decide a suitable venue in the university, gather audience, invite faculty members etc. (they need to get their plan ratified their professor). Outcome-- Host an interactive session with the NGO spokesperson 5) The groups to present their experience of **a day with the NGO** and inspire students to work for the cause.		
TOTAL					**61 hours**
	Assessment	Understand	Written Assessment of 20 Marks		
		Create	Project of 20 marks (E-Magazine 4 editions)		
		Analyze, Create	Focus Group Discussion 10 Marks		

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C1.6.1	Understand	Immersion (interview)	5
C1.6.2	Understand	Create CV	4
C1.6.3	Apply	Group Assignment- Form an NGO	5

C1.6.4	Understand	Group activities	3
C1.6.5	Create	Create and present a street play to articulate and amplify the social cause.	3
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand	Written Assessment, project and group discussion		50
Apply			
Analyze			

Text Books: There are no prescribed texts for Semester 2 – there will be handouts and reference links shared.

Reference Books:

1. Dr. A.P.J Abdul Kalam , Co-author--Arun Tiwari ,Guiding Souls : Dialogues on the purpose of life, 2005.
2. Dr. A.P.J Abdul Kalam , Co- author: Acharya Mahapragya,The Family and the Nation, Publishing year: 2015.
3. Dr. A.P.J Abdul Kalam, Co-author- Y.S.Rajan, The Scientific India: A twenty First Century Guide to the World around Us,2011.
4. Dr. A.P.J Abdul Kalam ,Forge Your Future: Candid, Forthright, Inspiring , 2014.
5. Peter H. Diamandis and Steven Kotler , Abundance: The Future is Better Than You Think, Free Press, 21 Feb, 2012.
6. Simon Sinek , Start With Why: How Great Leaders Inspire Everyone to Take Action, Penguin, 6 October 2011.
7. Sandra Moriarty, Nancy D. Mitchell, William D. Wells, Advertising & IMC: Principles and Practice, Pearson Education India, 15 June 2016.

Web References:

- ETHICS FUNDAMENTALS AND APPROACHES TO ETHICS https://www.eolss.net/Sample-Chapters/C14/E1-37-01-00.pdf
- A Framework for Making Ethical Decisions https://www.brown.edu/academics/science-and-technology-studies/framework-making-ethical-decisions
  Five Basic Approaches to Ethical Decision-http://faculty.winthrop.edu/meelerd/docs/rolos/5_Ethical_Approaches.pdf

Online Resources:

- https://youtu.be/CsaTslhSDI
- https://m.youtube.com/watch?feature=youtu.be&v=IIKvV8_T95M
- https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y
- https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be
- https://m.youtube.com/watch?v=7sLLEdBgYYY&feature=youtu.be

Course Outcomes:

After completion of the course, the student will be able to

- understand tools of structured written communication [U]
- use tools of structured written communication [AP]
- use electronic/social media to share concepts and ideas [AP]
- develop materials to create an identity for an organization dedicated to a social cause [C]
- understand the basics of presentation [U]
- apply effective techniques to make presentations. [AP]
- assess presentations based on given criteria [E]
- understand tools for quick reading. [U]
- apply the basic concept of speed reading, skimming and scanning. [AP]
- identify individual personality types and role in a team. [U]
- recognize the concepts of outward behavior and internal behavior. [AP]
- understand the basic concepts of Morality and Diversity. [U]
- create communication material to share concepts and ideas. [C]
- argue on a topic based on morality and diversity. [E]
- articulate opinions on a topic with the objective of influencing others. [C]
- organize an event to generate awareness and get support for a cause. [C]

19EMC182: ENVIRONMENTAL SCIENCES

L	T	P	C
2	0	0	0

The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation leads to pollution, finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

Course objectives:

- Familiarize the students about the importance of the environmental studies.
- Acquaint with different natural resources and their associated problems.
- Introduce various ecosystems, values of biodiversity and their conservation.
- Expose to today's pollution levels and their impacts.
- Create awareness on different social issues such as conservation of water, green building concept.
- Study on present population scenario, its impacts and role of informational technology on environment and human health.

UNIT I **10 L**

Introduction to Environment and Natural Resources: Introduction to environment: Definition, scope and importance, multidisciplinary nature of environment, need for public awareness. Natural Resources: Renewable and non-renewable resources, natural resources and associated problems. Forest resources: Uses, Reasons for over-exploitation, deforestation effects, timber extraction, case studies. Water resources: Use and over – utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems. Mineral resources: Uses, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, Impacts of overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, use of renewable and non-renewable energy sources, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Learning Outcomes:

After the completion of this unit, student will be able to

- list different renewable and non-renewable resources. (L1**)**
- learn how the over-exploitation of natural resources impact human life. (L1)
- demonstrate the role of an individual in the conservation of natural resources. (L2)
- explain the equitable use of natural resources for sustainable lifestyles. (L2)

UNIT II **9 L**

Ecosystems and Biodiversity: Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological pyramids, Energy flow in the ecosystem (10% law), Ecological succession. Biogeochemical cycle: (Nitrogen, carbon, Phosphorus cycle). Introduction, types, structure and function of the following ecosystem: - Forest ecosystem. Grassland ecosystem. Desert ecosystem. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Definition, Levels of biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega – diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In – situ and Ex-situ conservation of biodiversity.

Learning Outcomes:

After completion of this unit, student will be able to

- learn how ecosystem functions. (L1)
- explain the structure and function of terrestrial and aquatic ecosystems. (L2)
- illustrate the values and threats to biodiversity. (L2)
- explain the importance of conservation of biodiversity. (L2)

UNIT III **8 L**

Environmental Pollution and Control: Environmental Pollution: Definition, causes, effects and control measures: Air Pollution, Water pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards, Solid waste Management, e-waste, Hazardous waste management. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: floods, earthquake, cyclone and landslides.

Learning Outcomes:

After completion of this unit, student will be able to

- list causes, effects and control measures of pollution (air, water & soil). (L1)
- classify different types of pollutants. (L2)
- explain disaster management of floods, earthquake, cyclone and landslides. (L2)
- identify the pollution related case studies. (L3)
- demonstrate the role of an individual in prevention of pollution. (L3)

UNIT IV **9 L**

Social Issues, Global Environment Problems and Efforts: From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management, Remote sensing and GIS methods. Resettlement and rehabilitation of people: its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions. Green building concept, Environmental Impact Assessment (Checklists, matrix methods), Environmental

Management Plan, Climate change: global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Learning Outcomes:

After the completion of this unit, student will be able to

- explain different water conservation methods. (L2)
- compare remote sensing and GIS methods. (L2)
- apply green building concept. (L3)
- demonstrate the consequences of global warming, acid rains and ozone layer depletion. (L3)
- analyze environmental impact assessment and management plan. (L4)

UNIT V **6 L**

Human Population and Environment Legislation: Population growth, variation among nations. Family Welfare programme. Environment and human health. HIV/AIDS, Human rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Environmental Protection Act, Pollution prevention act. Issues involved in enforcement of environmental legislation. Public awareness. Project Work.

Learning Outcomes:

After completion of this unit, student will be able to

- compare population growth and variation among nations. (L2)
- apply value education. (L3)
- classify women and child welfare. (L3)
- distinguish different environmental legislation acts and issues involved in enforcement of legislation. (L4)
- analyze the role of information technology in environment and human health. (L4)

Text Book(s)

1. Anubha Kaushik and C.P. Kaushik, Text book of environmental studies New Age International Publisher, 2014.
2. ErachBarucha, Text book of environmental studies for undergraduates courses, published by – University Grants Commission, University Press, 2005.
3. AninditaBasak, Environmental Studies, Pearson, 2009.

References:

1. D.K. Asthana and Meera Asthana, A Text book of Environmental Studies, S. Chand, 2010.
2. P.M Cherry, Solid and Hazardous Waste Management, 1/e, CBS Publisher, 2016.
3. Charles H. Ecclestion, Environmental Impact Assessment, CRC Press, 2011.
4. K.K. Singh, Natural Resources Conservation and Management, MD Publications, 2008.
5. J. Jeffrey Peirce, Ruth F. Weiner and P. AarneVesilind, Environmental Pollution and Control, Butterworth-Heinemann, 1998.
6. James Maclaurin and Kim Sterelny, What is Biodiversity, The University of Chicago Press, 2008.
7. R.B. Mandal, Introductory Methods in Population Analysis, Concept Publishing Co, 2007.

Course Outcomes:

After the completion of the course, the student will be able to

- explain about environment and natural resources. (L2)
- illustrate the values and threats to biodiversity. (L2)
- identify the pollution related case studies. (L3)
- demonstrate the consequences of global warming, acid rains and ozone layer depletion. (L3)
- analyze the role of information technology in environment and human health. (L4)

Semester III

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB201	Formal Language and Automata Theory	PC	3	0	0	3
2	19ECB231	Computer Organization & Architecture	PC	3	0	4	5
3	19ECB233	Object Oriented Programming	PC	2	0	4	4
4	19EMA209	Computational Statistics	BS	3	0	2	4
5	19ECB235	Software Engineering	PC	3	0	2	4
6	19EMC281	Constitution of India (Non Credit)	MC	2	0	0	0
Total						**20**	

19ECB201: FORMAL LANGUAGE AND AUTOMATA THEORY

L	T	P	C
3	0	0	3

Automata Theory comprised of theoretical computer science and discrete mathematics is the study of abstract machines for solving computational problems. This course is intended to help the students to gain knowledge in fundamentals of theory of computation that can recognize formal languages typically illustrated by the Chomsky hierarchy. This knowledge can further be applied widely in compiler construction, artificial intelligence.

Course objectives:

The course is intended to

- Impart the mathematical concepts of theoretical computer science from the perspective of formal languages in the design of solving computational machines.
- Familiarize various formal language classes, grammar and their relationships.
- Demonstrate various finite state machines which recognize formal languages.
- Design grammars which recognize different formal languages
- Prove or disprove theorems in automata theory using its properties
- Determine the decidability and intractability of computational problems

Prerequisites: Discrete Mathematical Structures, Set theory.

UNIT I **8 L**

Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.

Finite Automata: Deterministic finite automata (DFA), Non deterministic finite automata (NFA) and equivalence with DFA,

Learning Outcomes:

After completion of this unit, the student will be able to

- illustrate the Chomsky hierarchy of classes of languages. (L2)
- illustrate the central concepts of automata theory. (L2)
- construct Non-Deterministic Finite Automata and Deterministic Finite Automata. (L3)
- list out various finite state machines. (L1)

UNIT II **8 L**

Regular languages and finite automata: Regular expressions and languages, equivalence of DFA with regular expressions, regular grammars and equivalence with finite automata, properties of regular languages, *Kleene's theorem,* pumping lemma for regular languages, Myhill-Nerode theorem and its uses, minimization of finite automata.

Learning Outcomes:

After completion of this unit, the student will be able to

- interpret various operations and properties of regular expressions. (L2)
- construct a Non-Deterministic Finite Automaton for a regular expression. (L3)
- decide whether a language is a regular language or not using pumping lemma theorem. (L5)
- construct the equivalent minimized Deterministic Finite Automata. (L3)

UNIT III **10 L**

Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), parse trees, ambiguity in CFG, Simplification of CFG, Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.

Learning Outcomes:

After completion of this unit, the student will be able to

- classify the grammars of the formal languages. (L2)
- construct an unambiguous grammar from ambiguous grammar. (L3)
- decide whether a language is context free language or not using pumping lemma theorem. (L5)
- illustrate the design of Pushdown Automata for Context Free Languages. (L2)
- analyze the equivalence of Pushdown Automata with Context Free Languages. (L4)

UNIT IV **9 L**

Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.

Turing machines: The basic model for Turing machines (TM), Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TM's as enumerators.

Learning Outcomes:

After completion of this unit, the student will be able to

- illustrate the design of Turing machine for unrestricted grammars. (L2)
- identify various programming techniques in the design of Turing machines. (L3)
- distinguish between Turning Machines and Linear-Bounded Automata. (L4)

UNIT V **8 L**

Undecidability: Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

Basic Introduction to Complexity: Introductory ideas on Time complexity of deterministic and nondeterministic Turing machines, P and NP, NP- completeness, Cook's Theorem, other NP - Complete problems.

Learning Outcomes:

After completion of this unit, the student will be able to

- illustrate various undecidable problems. (L2)
- illustrates examples of undecidable problems. (L2)
- demonstrate the significance of the P & NP -completeness. (L3)
- analyze the time complexity of deterministic and non-deterministic Turing machines. (L4)

Laboratory

1. *YACC, the parser-generating tool (Chapter 5 of Introduction to Automata Theory, Languages, and Computation* John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman.*)*

Text Book:

2. John E. Hop croft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3/e, Pearson Education India, 2008.

References:

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, 2/e, Pearson, 2015.
2. Dexter C. Kozen, Automata and Computability, 1/e, Springer, 2007.
3. Michael Sipser, Introduction to the Theory of Computation, 3/e, Cengage, 1 October 2014.
4. John Martin, Introduction to Languages and the Theory of Computation, 3/e, McGraw Hill Education, 6 June 2007.
5. M. R. Garey and D. S. Johnson, Computers and Intractability: A Guide to the Theory of NP Completeness, W. H. Freeman, 26 April 1979.

Course Outcomes:

After completion of this course, the student will be able to

- identify different finite state machines for modeling and solving computational problems. (L3)
- illustrate the concepts in the design of Finite State Machines to recognize Regular Languages. (L2)
- analyze the relation between grammar and language, and design Context Free Grammars for formal languages. (L4)
- construct Pushdown Automata for the Context Free Languages and analyze the equivalence between them. (L3)
- design and analyze Turing Machine for Unrestricted Grammar. (L6)

19ECB231: COMPUTER ORGANIZATION &ARCHITECHTURE

L	T	P	C
3	0	4	5

This course deals with the basic concepts of computer organization and architecture that can help the students to have a clear view as to how a computer system works. Computer Architecture talks about the basic digital hardware with which the processor is built and Computer Organization talks about the basic interface the digital hardware gives to the compiler and the operating systems to support the user demands. This course will also expose the students to the basic concepts of memory and I/O organization in a computer system

Course objectives:

- Introduce register transfer language and express micro-operations in symbolic form
- Familiarize with the instruction set, addressing modes and instruction execution cycle
- Demonstrate various arithmetic algorithms and the design of logic circuits for various arithmetic operations
- Teach the design approaches of hardwired & micro-programmed control unit and the concepts of parallel processing & pipelining
- Expose to different ways of communicating I/O devices with the processor and I/O transfer methods
- Explain the concept of memory organization

UNIT I **12 L**

Revision of basics in Boolean logic and Combinational/Sequential Circuits.
Functional blocks of a computer: CPU, memory, input-output subsystems, control unit.
Instruction set architecture of a CPU: Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.

Learning Outcomes:
After completion of this unit, the student will be able to

- identify and explain the functional blocks of a computer. (L3)
- demonstrate the concepts of register transfer logic. (L2)
- illustrate the instruction execution cycle flow chart. (L2)
- explain different types of instructions and recognize their addressing modes. (L2)
- outline instruction sets of some common CPUs. (L2)

UNIT II **10 L**

Data representation: Signed number representation, fixed and floating point representations, character representation.
Computer arithmetic: Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and-add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format.

Learning Outcomes:
After completion of this unit, the student will be able to

- explain how to represent a number in fixed point, floating point and IEEE 754 formats. (L2)
- demonstrate the design of logic circuits for performing various arithmetic operations. (L2)
- illustrate various arithmetic algorithms and show the procedure for implementing with digital hardware. (L2)

UNIT III **12 L**

Introduction to x86 architecture.
CPU control unit design: Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU.
Memory system design: Semiconductor memory technologies, memory organization.

Learning Outcomes:
After completion of this unit, the student will be able to

- analyze the logic circuits of hardwired control unit. (L4)
- examine the microcode for various operations in micro-programmed control unit. (L4)
- distinguish between the design approaches of hardwired and micro-programmed control unit. (L4)
- summarize various semiconductor memory technologies. (L2)

UNIT IV **12 L**

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, USB
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.
Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Learning Outcomes:
After completion of this unit, the student will be able to

- explain various I/O transfer techniques. (L5)
- define an interrupt and explain the process involved in handling interrupts. (L1)
- classify different types of peripheral devices of computer and I/O device interfaces. (L2)
- discuss the concepts of parallel processing, pipelining. (L6)

UNIT V **10 L**

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Learning Outcomes:

After completion of this unit, the student will be able to

- analyze some of the design issues in terms of speed, cost and performance. (L4)
- summarize various replacement algorithms used in cache memory. (L2)
- appraise the use of cache memory and compare various cache memory mapping techniques. (L5)

Text Books:

1. M. M. Mano, Computer System Architecture, 3/e, Prentice Hall of India, New Delhi, 1993.
2. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 4/e, Morgan Kaufmann, 13 October 2011.
3. Carl Hamacher, Computer Organization and Embedded Systems, 6/e, McGraw-Hill Education, 2017.

Reference Books:

1. John P. Hayes, Computer Architecture and Organization,3/e, McGraw Hill Education,1 July 2017.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, 10/e, Pearson Education India,29 September 2016.
3. Vincent P. Heuring and Harry F. Jordan, Computer System Design and Architecture, 2/e, Prentice Hall, 23 March 2006.

Course Outcomes:

After Completion of this course, the student will be able to:

- make use of register transfer language to express micro operations in symbolic form. (L3)
- illustrate the addressing modes, instruction set and instruction execution cycle. (L2)
- demonstrate the arithmetic algorithms & logic circuits for various arithmetic operations and represent a number in different formats. (L2)
- examine the hardwired and micro-programmed control design approaches. (L5)
- explain various I/O transfer techniques, I/O interfacing techniques and pipelining. (L2)
- appraise the memory organization of a computer and semiconductor memory technologies used in memories. (L5)

COMPUTER ORGANIZATION &ARCHITECHTURE LABORATORY

List of Lab Experiments:

1. Circuits on breadboard or simulators

(a) Implementation of Combinational Digital/Boolean Circuits: Adder, Subtractor, Multiplication Module, Division Module, Multiplexer, Demultiplexer, Encoder, Decoder.

(b) Implementation of Sequential Circuits: Counters, Linear Feedback Shift Registers (LFSR)

2. C/C++ programming to understand the formats of char, int, float, double, long etc.

3. Machine language programming on x86 or higher version kits or simulators:

(i) Add/subtract/multiplication/division/GCD/LCM

(ii) Accessing some specific memory locations/ports

(iii) Counting odd and even integers from a series of memory locations

(iv) Printing values of selected registers

(v) Handing interrupts

Course Outcomes:

At the end of the course, students will be able to

- identify various hardware components of a Personal Computer. (L3)
- install Operating System. (L3)
- troubleshoot hardware and software. (L3)
- work with Internet and Search engines. (L4)
- make use of Excel and PowerPoint. (L6)

19ECB233: OBJECT ORIENTED PROGRAMMING

L T P C
2 0 4 4

The study of Object Oriented Programming (OOP) provides us with the ability to create objects that tie together both properties and behaviors into a self-contained, reusable package. This allows programs to be written in a more modular fashion, which makes them easier to write and understand, and also provides a higher degree of code-reusability. These objects also provide a more intuitive way to work with our data by allowing us to define how we interact with the objects, and how they interact with other objects.

Course objectives:

- Differentiate the fundamental concepts of C and C++.
- Able to define, declare and implement classes and objects.
- Examine the working of Control structures in C++ programs.
- Understand various Inheritance, polymorphism and Exception handling mechanism.
- Construct applications using generic programming concepts
- Create various Object Oriented Design and Modeling

UNIT I **10 L**

Procedural programming, An Overview of C: Types Operator and Expressions, Scope and Lifetime, Constants, Pointers, Arrays, and References, Control Flow, Functions and Program Structure, Namespaces, error handling, Input and Output (*C*-way), Library Functions (*string*, *math*, *stdlib*), Command line arguments, Pre-processor directive

Some difference between C and C++: Single line comments, Local variable declaration within function scope, function declaration, function overloading, stronger type checking, Reference variable, parameter passing – value vs reference, passing pointer by value or reference, Operator new and delete, the typecasting operator, Inline Functions in contrast to macro, default arguments

Learning Outcomes:

After completion of this unit, the student will be able to

- identify various ways of representing data types. (L2)
- classify on pre-defined libraries. (L2)
- describe functions and macros. (L2)

UNIT II **10 L**

The Fundamentals of Object Oriented Programming: Necessity for OOP, Data Hiding, Data Abstraction, Encapsulation, Procedural Abstraction, Class and Object.

More extensions to C in C++ to provide OOP Facilities: Scope of Class and Scope Resolution Operator, Member Function of a Class, private, protected and public Access Specifier, this Keyword, Constructors and Destructors, friend class, error handling (exception)

Learning Outcomes:

After completion of this unit, the student will be able to

- explain fundamental concepts of OOP. (L2)
- give examples on C and C++ Operators. (L2)
- prepare constructors, friend functions, macros and exceptions. (L3)

UNIT III **10 L**

Essentials of Object Oriented Programming: Operator overloading, Inheritance – Single and Multiple, Class Hierarchy, Pointers to Objects, Assignment of an Object to another Object, Polymorphism through dynamic binding, Virtual Functions, Overloading, overriding and hiding, Error Handling

Learning Outcomes:

After completion of this unit, the student will be able to

- summarize the object oriented programming essentials. (L2)
- demonstrate on inheritance and polymorphism. (L3)
- construct virtual functions and exception handling. (L3)

UNIT IV **10 L**

Generic Programming: Template concept, class template, function templates, template specialization.

Input and Output: Streams, Files, Library functions, formatted output.

Learning Outcomes:

After completion of this unit, the student will be able to

- analyze object oriented programming and generic programming. (L4)
- compose on various templates classes. (L5)
- compare input and output streams and library function. (L5)

UNIT V **10 L**

Object Oriented Design and Modeling: UML concept, Use case for requirement capturing, Class diagram, Activity diagram and Sequence Diagram for design, Corresponding C++ code from design

Learning Outcomes:

After completion of this unit, the student will be able to

- design object oriented design and modeling. (L6)
- organize different modeling C++ code from design. (L3)
- evaluate various object oriented design diagrams. (L5)

Text Books:

1. Bjarne Stroustrup, The C++ Programming Language, 4/e, Addison Wesley, 2013.
2. Debasish Jana, C++ and Object-Oriented Programming Paradigm,3/e, PHI Learning Pvt. Ltd,2014.

Reference Books:

1. Bjarne Stroustrup, Programming – Principles and Practice Using C++, 2/e, Addison Wesley, 2014.
2. Bjarne Stroustrup, The Design and Evolution of C++, Addison Wesley, 1994.

Course Outcomes:

After Completion of this course, the student will be able to:

- recall simple applications by using classes and objects. (L1)
- illustrate operators, function and constructors. (L2)
- construct various applications of inheritance and polymorphism. (L3)
- analyze object oriented programming and generic programming. (L4)
- develop exception handling in object oriented programming development. (L5)
- assess UML design to best performance for a given application. (L6)

OBJECT ORIENTED PROGRAMMING LABORATORY

This Lab provides hands-on experience in designing, implementing, and using the most-commonly used class and object concept. Implementation of different constructors, destructors, inheritance, polymorphism, templates, exception handling and UML Design.

List of Laboratory Experiments

1. Parameter passing: passing parameter by value vs by reference, passing array as constant pointer
2. Function overloading: writing string operations like strcat and strncat, strcpy and strncpy as overloaded functions.
3. Dynamically allocating space for a pointer depending on input and doing this repeatedly, depending on different inputs and finally de-allocating the pointer.
4. Define class complex with all possible operations: constructor, destructor, copy constructor, assignment operator with the data members stored as pointer to integers.
5. Define class vector of integers with all possible operations like constructor, destructor, copy constructor and assignment operators
6. Define class matrix of integers with all possible operations like constructor, destructor, copy constructor and assignment operators
7. Define class matrix of integers using vector, with all possible operations like constructor, destructor, copy constructor and assignment operators
8. Define class stack, queue, linked-list, array, set using some data-type (int) with data members kept as private and functions kept in both protected and public sections.
9. Define class complex with all possible operators: constructor, destructor, copy constructor, assignment operator and operators >, <, >=, <=, ==, ++ (pre and post), +, +=, ( ), with the data members stored as pointer to integers.
10. Define class vector of integers with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( )
11. Define class matrix of integers with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( ).
12. Define class matrix of integers using vector, with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( ).
13. Define stack and queue inherited from array class, with standard functions and operators
14. Define a class called ‘array’ with data type passed as template type with constructor, destructor, copy constructor and assignment operators and index operator.
15. Define template functions for compare and use it in the algorithms like bubble sort, insertion sort, merge sort.
16. Formatted input-output examples
17. Input manipulators
18. Overriding operators <<, >>
19. Define class model for complex number, student class, book class and show it using UML diagram as well as concrete class.
20. Show behavioural modelling through sequence diagram and activity diagram for workflow in a typical log-in, log-out situation.

19EMA209: COMPUTATIONAL STATISTICS

L	T	P	C
3	0	2	4

This course emphasizes both theory and applications of statistics and is structured to provide knowledge and skills in depth necessary for the employability of students in data analytics. The pre-requisite of this course is system and extensive computer training of statistical computations including standard software packages such as MATLAB, R, SPLUS, SYSTAT & PYTHON.

Course objectives:

- Familiarize the students with the foundations of Computational Statistics.
- Build empirical models to engineering and scientific data by using multiple regression techniques.
- Understand Principal Component Analysis for Factor Analysis in crystal clear manner
- Understand the overall purpose and procedures of exploratory and confirmatory factor analysis.
- Sensitize the basic ideas and concepts in cluster analysis including hierarchical and non-hierarchical clustering methods and their application.
- Account for important theorems and concepts in multivariate analysis.

UNIT I **8 L**

Multivariate Normal Distribution: Multivariate Normal Distribution Functions, Conditional Distribution and its relation to regression model, Estimation of parameters.

Learning Outcomes:

At the end of this unit, the student will be able to

- gain experience of how the various methods are applied, and results interpreted, in practice. (L3)
- develop the ability to implement methods computationally (with Python). (L3)
- develop the ability to evaluate the suitability of, and compare, different methods in practice. (L3)
- determine the shape of the multivariate normal distribution from the eigenvalues and eigen vectors. (L5)
- perform statistical tests of the mean value vector of a multivariate normal distribution. (L3)

UNIT II **10 L**

Multiple Linear Regression Model: Standard multiple regression models with emphasis on detection of collinearity, outliers, non-normality and autocorrelation, Validation of model assumptions.

Multivariate Regression:–Discriminant Analysis: Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties.

Learning Outcomes:

At the end of this unit, the student will be able to

- use multiple regression techniques to build empirical models in engineering and scientific data. (L3)
- understand how the method of least squares extends to fitting multiple regression models. (L2)
- use the regression model to estimate the mean response, and to make predictions and to construct confidence intervals and prediction intervals. (L3)
- build regression models with polynomial terms. (L3)
- use stepwise regression and other model building techniques to select the appropriate set of variables for a regression model. (L3)

UNIT III **8L**

Principal Component Analysis: Principal components, Algorithm for conducting principal component analysis, deciding on how many principal components to retain, H-plot.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze a data table in which observations are described by several inter-correlated quantitative dependent variables. (L4)
- use as a tool in exploratory data analysis and for making predictive models. (L5)
- visualize genetic distance and relatedness between populations. (L5)
- calculate the data covariance (or correlation) matrix of the original data. (L4)
- calculate PCA is either done by singular value decomposition of a design matrix. (L3)

UNIT IV **8L**

Factor Analysis: Factor analysis model, extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables. (L4)
- conduct their own analyses by using factor analysis. (L5)
- understand the limitations of this approach and the use of a variety of diagnostic tools. (L2)
- communicate the results of such models to social sciences audiences. (L4)
- identify theoretical and practical differences between exploratory and confirmatory factor analysis. (L3)

UNIT V **8L**

Cluster Analysis: Introduction, Types of clustering, Correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters.

Learning Outcomes:

At the end of this unit, the student will be able to

- conduct hierarchical cluster analysis and k-means clustering. (L4)
- identify analyse K-means and Two-step clustering. (L3)
- apply normalization of data appropriately in cluster analysis. (L3)
- identify the assignment of cases to clusters. (L3)
- apply mixture models to multivariate data and interpret the output. (L3)

Text Books:

1. T.W. Anderson, An Introduction to Multivariate Statistical Analysis, 3/e, Wiley, 2009.
2. J.D. Jobson, Applied Multivariate Data Analysis, Vol I & II, 1/e, Springer, 1994.
3. H. Kris, Statistical Tests for Multivariate Analysis
4. Mark Lutz, Programming Python
5. Tim Hall and J-P Stacey, Python 3 for Absolute Beginners
6. Magnus Lie Hetland, Beginning Python: From Novice to Professional, *Edition, 2005.*

Reference Books:

1. D.A. Belsey, E. Kuh and R.E. Welsch, Regression Diagnostics , Identifying Influential Data and Sources of Collinearety,John Wiley & Sons,1980.
2. J. Neter, W. Wasserman and M.H. Kutner, Applied Linear Regression Models, 3/e, McGraw-Hill/Irwin, January 1, 1996.
3. A.S. Mulaik, The Foundations of Factor Analysis, 2/e, CRC Press, 2009.
4. D.C. Montgomery and E.A. Peck, Introduction to Linear Regression Analysis, 5/e, Wiley, 2012.
5. M.R. Anderberg, Cluster Analysis for Applications, 1/e, Academic Press, May 10, 2014.
6. D.F. Morrison, Multivariate Statistical Analysis, 4/e, Thomson, 2005.
7. Wes Mc Kinney, Python for Data Analysis.

COMPUTATIONAL STATISTICS LAB

Python Concepts, Data Structures, Classes: Interpreter, Program Execution, Statements, Expressions, Flow Controls, Functions, Numeric Types, Sequences and Class Definition, Constructors, Text & Binary Files - Reading and Writing

Data Wrangling: Combining and Merging Datasets, Reshaping and Pivoting, Data Transformation, String Manipulation, Regular Expressions.

Data Aggregation, Group Operations, Time series: GoupBy Mechanics, Data Aggregation, Groupwise Operations and Transformations, Pivot Tables and Cross Tabulations, Time Series Basics, Data Ranges, Frequencies and Shifting.

Visualization in Python: Matplotlib package, Plotting Graphs, Controlling Graph, Adding Text, More Graph Types, Getting and setting values, Patches

Multivariate data analysis: Multiple regression, multi variate regression, cluster analysis with various algorithms, factor analysis, PCA and linear discriminant analysis. Various datasets should be used for each topic.

Text Books:

1. Programming Python, Mark Lutz, 4/e, O'Reilly Media, January 18, 2011.
2. Python 3 for Absolute Beginners, Tim Hall and J-P Stacey, 1/e, Apress, October 29, 2009.
3. Beginning Python: From Novice to Professional, Magnus Lie Hetland, 2/e, Apress, 2008.

Reference Books:

1. Python for Data Analysis, Wes Mc Kinney, 2/e, O'Reilly Media, October 24, 2017.

Course Outcomes:

After completion of the course, the student will be able to

- use the equation of a linear function to model a data set. (L3)
- understand how to develop Null and Alternative Hypotheses. (L3)
- find the differences among parametric and nonparametric inferences. (L2)
- identify and interpret a non-seasonal ARIMA model. (L3)
- import, review, manipulate and summarize data-sets in R. (L4)

19ECB235: SOFTWARE ENGINEERING

L	T	P	C
3	0	2	4

The study of software engineering is a fundamental component of a computer science education, serves as the foundation upon which many other companies to build the many applications. Knowledge of software engineering is a must for students who wish to work in design, implementation, testing or maintenance of any software system. Management of a project, importance of metrics and testing techniques is the major focus of the course.

Course objectives:

- Introduce various concepts of engineering approaches to software development.
- Demonstrate the estimation techniques of schedule, effort, size and cost.
- List the various quality attributes.
- Examine the different requirements and prepare the tables
- Examine the design concepts and apply the object oriented concepts
- Experiment and evaluate different types of testing techniques.

UNIT I **8 L**

Introduction: Programming in the small vs. programming in the large; software project failures and importance of software quality and timely availability; engineering approach to software development; role of software engineering towards successful execution of large software projects; emergence of software engineering as a discipline.

Learning Outcomes:

After completion of this unit, the student will be able to

- define the programming in the small and large areas (L1)
- understand the importance of quality with in the environment of software engineering (L2)
- outline the role of software engineering towards the implementation of large projects (L1)

UNIT II **10 L**

Software Project Management: Basic concepts of life cycle models – different models and milestones; software project planning –identification of activities and resources; concepts of feasibility study; techniques for estimation of schedule and effort; software cost estimation models and concepts of software engineering economics; techniques of software project control and reporting; introduction to measurement of software size; introduction to the concepts of risk and its mitigation; configuration management.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand the importance of different models and milestones (L2)
- annotate the knowledge of factors of project environment (L2)
- apply the techniques of software project control and reporting (L3)

UNIT III **8L**

Software Quality and Reliability: Internal and external qualities; process and product quality; principles to achieve software quality; introduction to different software quality models like McCall, Boehm, FURPS / FURPS+, Dromey, ISO – 9126; introduction to Capability Maturity Models (CMM and CMMI); introduction to software reliability, reliability models and estimation.

Learning Outcomes:

After completion of this unit, the student will be able to

- categorize the quality types (L2)
- list the different quality attributes (L1)
- choose the reliability model is suitable to the project (L3)

UNIT IV **8L**

Software Requirements Analysis, Design and Construction: Introduction to Software Requirements Specifications (SRS) and requirement elicitation techniques; techniques for requirement modeling – decision tables, event tables, state transition tables, Petri nets; requirements documentation through use cases; introduction to UML, introduction to software metrics and metrics based control methods; measures of code and design quality.

Object Oriented Analysis, Design and Construction: Concepts -- the principles of abstraction, modularity, specification, encapsulation and information hiding; concepts of abstract data type; Class Responsibility Collaborator (CRC) model; quality of design; design measurements; concepts of design patterns; Refactoring; object oriented construction principles; object oriented metrics.

Learning Outcomes:

After completion of this unit, the student will be able to

- summarize the different types of requirements (L2)
- develop a tables based on available requirements to implement a project (L3)
- examine the suitable metrics to measure the code and design quality (L4)
- examine the different design concepts (L4)

UNIT V **10L**

Software Testing: Introduction to faults and failures; basic testing concepts; concepts of verification and validation; black box and white box tests; white box test coverage – code coverage, condition coverage, branch coverage; basic concepts of black-box tests – equivalence classes, boundary value

tests, usage of state tables; testing use cases; transaction based testing; testing for non-functional requirements – volume, performance and efficiency; concepts of inspection.

Learning Outcomes:

After completion of this unit, the student will be able to

- examine the basic testing concepts (L4)
- evaluate the testing techniques based on our problem (L5)
- experiment all test cases in every type of testing on given project (L5)

Text Books:

1. Ian Somerville, Software Engineering, 9/e, Pearson, 2016.

Reference Books:

1. Carlo Ghezzi, Jazayeri Mehdi, Mandrioli Dino, Fundamentals of Software Engineering, 2/e, Pearson Hall, 2002.
2. Michael Jackson, Software Requirements and Specification: A Lexicon of Practice, Principles and Prejudices, ACM Press, 1/e, 2014.
3. Ivar Jacobson, Grady Booch, James Rumbaugh, The Unified Development Process, Addison Wesley Professional, 1999.
4. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Object-Oriented Reusable Software, 1st edition, Addison Wesley, 1994.
5. Norman E Fenton, Shari Lawrence Pfleeger, Software Metrics: A Rigorous and Practical Approach, 2/e, PWS Publishing Company, 1997.
6. Shari Lawrence Pfleeger and Joanne M. Atlee, Software Engineering: Theory and Practice, Pearson, 2010.
7. Bertrand Meyer, Object-Oriented Software Construction, 2nd Edition, 1997.
8. Ivar Jacobson, Object Oriented Software Engineering: A Use Case Driven Approach, 1st edition, Addison-Wesley, 2011.
9. Bertrand Meyer, Touch of Class: Learning to Program Well with Objects and Contracts, Springer, 2013.
10. Martin Fowler, UML Distilled: A Brief Guide to the Standard Object Modeling Language, 3rd edition, Pearson, 2015.
11. Roger S. Pressman, Software Engineering - A Practitioner's Approach, 8/e, McGraw-Hill International Edition, 2017.

Course Outcomes:

After Completion of this course, the student will be able to:

- explain various basic concepts of software engineering approaches (L2)
- illustrate the techniques for size, effort, schedule and cost (L3)
- classify the different type of quality attributes are required to provide the quality (L4)
- construct the tables based on available requirements (L3)
- examine the various design concepts (L4)
- evaluate the test cases and experiment all testing techniques (L5)

SOFTWARE ENGINEERING LABORATORY

This Lab provides hands-on experience in designing, implementing, and testing the most-commonly implement the software projects. Construct the test case designs and implement using different available tools

List of Practical Experiments:

Development of requirements specification, function oriented design using SA/SD, object-oriented design using UML, test case design, implementation using C++ and testing. Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle.

19EMC281: CONSTITUTION OF INDIA

(Mandatory Course)

L	T	P	C
2	0	0	0

UNIT I **5 L**

Introduction to Indian Constitution: Constitutional history, constituent assembly, salient features of the constitution, significance of, amending process of the constitution.

UNIT II **5 L**

Rights and Duties: Citizenship, fundamental rights and directive principles, fundamental duties.

UNIT III **5 L**

Union Government: President and vice president, election, removal and powers, prime minister and council of ministers, parliament, supreme court, union, state relations, emergency provisions.

UNIT IV **5 L**

State and Local Governments: Governor, state legislature, assembly and council, chief minister and council of ministers, high court, rural and urban local governments with special reference to 73rd and 74th constitutional amendment acts.

8 L

UNIT V

Other Constitutional and Statutory Bodies: Comptroller and auditor general, election commission, finance commission, attorney general and advocate general, union public service commission (UPSC), state public service commissions (SPSCs), tribunals, national human rights commission (NHRC).

Text Book(s):

1. J. C. Johari, Indian Government and Politics, Vishal Publications, Delhi, 2009.
2. M. V. Pylee, Introduction to the Constitution of India, 5/e, Vikas Publishing House, Mumbai, 2007.

References:

1. D.D. Basu, Introduction to the Indian Constitution, 21/e, Lexis Nexis, Gurgaon, India, 2011.
2. Subhas C. Kashyap, Our Constitution, 2/e, National Book Trust India, New Delhi, 2013.

Semester IV

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB232	Operating Systems	PC	3	0	2	4
2	19ECB234	Database Management Systems	PC	3	0	2	4
3	19ECB236	Software Design with UML	PC	2	0	2	3
4	19EID204	Introduction to Innovation, IP Management and Entrepreneurship	ES	3	0	0	3
5	19EID236	Design Thinking	ES	2	0	2	3
6	19EME236	Operations Research	MS	2	0	2	3
7	19EMC282	Essence of Indian Traditional Knowledge (Non Credit)	MC	2	0	0	0
Total					**20**		

19ECB232: OPERATING SYSTEMS

L	T	P	C
3	0	2	4

The main aim of this course is to understand the abstraction and mechanism of an Operating system and students will gain the knowledge of how Operating system creates and coordinates the functions of the OS. The students will be able to implement the functions of operating system at the end of the course.

Course objectives:

- Introduce students with basic concepts of operating system, its functions and services.
- Provide the basic concepts of process management and synchronization.
- Familiarize the dead lock issues.
- Understand the various memory management schemes.
- Give exposure over I/O systems and mass storage structures.

UNIT I **12 L**

Introduction: Concept of Operating Systems (OS), Generations of OS, Types of OS, OS Services, Interrupt handling and System Calls, Basic architectural concepts of an OS, Concept of Virtual Machine, Resource Manager view, process view and hierarchical view of an OS.

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.

Learning Outcomes:

After completion of this unit, the student will be able to

- trace the development of OS. (L1)
- understand the structure of a computer system. (L2)
- compare different views of an OS. (L2)
- analyze the concept of a process, process life cycle, process states and state transitions. (L4)
- explore how modern OS supports threads. (L2)

UNIT II **12 L**

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.

Scheduling algorithms: Pre-emptive and non-pre-emptive, FCFS, SJF, RR; Multi processor scheduling: Real Time scheduling: RM and EDF.

Inter-process Communication: Concurrent processes, precedence graphs, Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Semaphores, Strict Alternation, Peterson's Solution, The Producer / Consumer Problem, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem, Barber's shop problem.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand how OS makes the computer more productive. (L2)
- select an algorithm for a particular system to make it more productive. (L1)
- implement different scheduling algorithms. (L3)
- list the various mechanisms to ensure the orderly execution of cooperating processes. (L1)

UNIT III **12 L**

Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Concurrent Programming: Critical region, conditional critical region, monitors, concurrent languages, communicating sequential process (CSP); Deadlocks - prevention, avoidance, detection and recovery.

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Learning Outcomes:

After completion of this unit, the student will be able to

- analyze about the deadlock situation and necessary conditions. (L4)
- describe methods that an OS can use to prevent, detect, handle and recover it deadlocks. (L1)
- implement files and directories. (L3)
- know the importance of file manipulations, organize and protect data stored in files. (L2)

UNIT IV **12 L**

Memory Management: Basic concept, Logical and Physical address maps,

Memory Allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction.

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page allocation, Partitioning, Paging, Page fault, Working Set, Segmentation, Demand paging, Page Replacement algorithms: Optimal, first in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Learning Outcomes:

After completion of this unit, the student will be able to

- know the various memory management schemes. (L2)
- analyze and implement various page replacement algorithms. (L4)

UNIT V **10 L**

I/O Hardware: I/O devices, Device controllers, Direct Memory Access, Principles of I/O.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

Case study: UNIX OS file system, shell, filters, shell programming, programming with the standard I/O, UNIX system calls.

Learning Outcomes:

After completion of this unit, the student will be able to

- coordinate the structure of I/O related software, hardware including interrupt handlers. (L2)
- format and manage the disk. (L6)

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts Essentials,9/e, Wiley India,2018.

Reference Books:

1. William Stallings, Operating Systems: Internals and Design Principles, Pearson Education, 2018.
2. Charles Patrick Crowley, Operating System: A Design-oriented Approach, 1/e, McGraw Hill Education, 2017.
3. Gary J. Nutt, Operating Systems: A Modern Perspective, Addison-Wesely Pub, 1997.
4. Maurice J. Bach, Design of the UNIX Operating Systems, 1/e, Pearson Education, 2015.
5. Daniel Pierre Bovet, Marco Cesati, Understanding the Linux Kernel, 2/e, O'Reilly, 2002.

Course Outcomes:

After Completion of this course, the student will be able to

- illustrate the basic and overall view of operating system. (L2)
- demonstrate the structure of operating systems, applications, and services provided by operating systems. (L2)
- analyze the concept of a process, process life cycle, process states and state transitions. (L4)
- implement various CPU scheduling strategies and process synchronization techniques. (L3)
- simplify & Resolve Deadlock handling situation. (L6)

- explain the importance of file structures in the Data Storage and Manipulation. (L2)
- implement and practice various memory-management schemes. (L3)
- coordinate the structure of I/O related software, hardware. (L5)
- familiar with Disk storage management. (L2)

Operating Systems Laboratory

1. Scheduling algorithms, simulation of First Cum First Serve CPU scheduling algorithm.
2. Simulation of Shortest Job First CPU scheduling algorithm.
3. Simulation of shortest job first preemptive CPU scheduling algorithm.
4. Bankers algorithm for dead lock avoidance.
5. Page replacement algorithms, implement First in First Out page replacement algorithm.
6. Page replacement algorithms, implement Least Recently Used page replacement algorithm.
7. Page replacement algorithms, implement Optimal Page replacement algorithm.
8. Write a program to implement concurrent programming constructs through semaphores -dining philosophers' problem, consumer- producer, readers-writers etc.
9. Write a C program to implement deadlock avoidance algorithms.
10. Write a program to page replacement algorithms.
11. Write a program to implement virtual memory.

19ECB234: DATATBASE MANAGEMENT SYSTEMS

L	T	P	C
3	0	2	4

The primary goal of a Database Management Systems is to provide an environment that is both convenient and efficient to use in retrieving and storing data. Facilitate the creation of data structures and relieve the programmer in setting up complicated files.

Course objectives:

- Impart the basic understanding of the theory and applications of database management systems.
- Give basic level understanding of internals of database systems.
- Expose to some of the recent trends in databases.

UNIT I **12L**

Introduction: Introduction to Database. Hierarchical, Network and Relational Models.

Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).

Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand the basic terminology of DBMS like data, database, database management systems. (L2)
- summarize Advantages of DBMS over File Systems. (L2)
- understand Levels of abstraction with three tier architecture. (L2)
- understand the basic query representation. (L2)
- construct an ER diagram for a given problem. (L3)

UNIT II **14L**

Relational query languages: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL server.

Relational database design: Domain and data dependency, Armstrong's axioms, Functional Dependencies, Normal forms, Dependency preservation, Lossless design.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand the difference between views and physical tables and working with views. (L2)
- represent given query in Relational Algebra and Relational Calculus. (L2)
- understands different types of query forms (simple queries, nested queries, and aggregated queries). (L2)
- implement Embedded SQL, cursors, triggers and active database using PL/SQL programs. (L5)
- understands the concept of functional dependencies (fds). (L2)
- acquires knowledge about different types of normal forms. (L2)
- implements normalization process on a simple database project. (L5)

UNIT III **10L**

Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

Storage strategies: Indices, B-trees, Hashing.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand how queries are processed, optimized and evaluated in a DBMS. (L2)
- understand what is a query execution plan. (L2)
- estimate the cost of a query execution plan. (L5)
- understand storage media and their basic properties. (L2)
- acquire knowledge on how data is stored using storage media in a DBMS. (L2)
- differentiate various indexing techniques. (L4)
- summarize why and how data needs to be indexed. (L2)

UNIT IV **10L**

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand transactions and their properties (ACID). (L2)
- identify the anomalies that occur without ACID. (L3)
- comprehend the locking protocols used to ensure Isolation. (L5)
- realize the logging techniques used to ensure Atomicity and Durability. (L4)
- know Recovery techniques used to recover from crashes. (L3)

UNIT V **10L**

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.

Learning Outcomes:

After completion of this unit, the student will be able to

- design and implement access control rules to assign privileges and protect data in databases. (L6)
- implement access control rule to secure data stored in databases. (L4)
- get knowledge of Parallel and distributed database systems. (L2)
- get acquaintance of New database architectures and query operators. (L2)
- develop new methods in databases based on knowledge of existing techniques.(L6)

Text Books:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, Database System Concepts,6/e, McGraw Hill,2014.

Reference Books:

1. J. D. Ullman, Principles of Database and Knowledge – Base Systems, Vol 1,1/e, Computer Science Press,1990.
2. R. Elmasri and S. Navathe, Fundamentals of Database Systems, 7/e, Pearson, June 18, 2015.
3. Serge Abiteboul, Richard Hull, Victor Vianu, Foundations of Databases, Pearson, 1994.

Course Outcomes:

After Completion of this course, the student will be able to:

- define, explain and illustrate the fundamental concepts of databases. (L2)
- construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures. (L3)
- model and design a relational database following the design principles. (L6)
- develop queries for relational database in the context of practical applications. (L3)
- define, explain and illustrate fundamental principles of data organization, query optimization and concurrent transaction processing. (L2)

DATATBASE MANGEMENT SYSTEMS LABORATORY

This Lab provides hands-on experience in Design and implements the database schema, Devise the queries using DDL, DML, TCL and DCL, develop programs using PL/SQL, Design and implement the project using Java and SQL.

List of Practical Experiments:

1. Developing a sample ER model for the specified database.
2. Familiarization of SQL DDL commands- create, alter, drop and truncate
3. Use of DML commands insert, update and delete. Constructing queries using Select formats
4. Use of different of operators for nested sub-queries.
5. Creating Views, grouping functions and performing joins.
6. Use of DCL and TCL commands.
7. PL/SQL programming environment
8. Declaring triggers and use of cursors.
9. Implementation of small database project

19ECB236: SOFTWARE DESIGN WITH UML

L	T	P	C
2	0	2	3

Engineering is a branch of Computer Science, which is a systematic presentation of engineering approaches in the growth of software product development. The software engineering course provides rich learning experience to educate software engineers for their achievement in a drastic change of computing field. Apply their foundations in software engineering to adapt to readily changing environments using the appropriate theory, principles and processes. The Unified Modeling Language (UML) is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems, as well as for business modeling and other non-software systems.

Course objectives:

- Explore and analyse different analysis and design models such as Object Oriented Models, Structured Analysis and Design Models etc.
- Create a requirements model using UML class notations and use-cases based on statements of user requirements, and to analyze requirements models given to them for correctness and quality.
- Understand the design and testing principles for software project development using UML
- Understand and analyse the object based view of the systems using UML
- Develop robust UML object based models for systems
- Inculcate necessary skills to handle complexity in software design by using UML

UNIT I **10L**

Introduction to Object Oriented Technologies and the UML Method.
Software development process: The Waterfall Model vs. The Spiral Model, The Software Crisis, description of the real world using the Objects Model, Classes, inheritance and multiple configurations, Quality software characteristics, Description of the Object Oriented Analysis process vs. the Structure Analysis Model.

Introduction to the UML Language.
Standards, Elements of the language, General description of various models, the process of Object Oriented software development, Description of Design Patterns, Technological Description of Distributed Systems.

Learning Outcomes:

After completion of this unit the student will be able to:

- describe key activities in software development and the role of modeling. (L1)
- explain the key concepts in software development such as risk and quality. (L2)
- outline the basics of an object-oriented approach to software development. (L2)
- identify the elements in building blocks of UML. (L3)

UNIT II **8 L**

Requirements Analysis Using Case Modeling: Analysis of system requirements, Actor definitions, writing a case goal, Use Case Diagrams, Use Case Relationships.

Transfer from Analysis to Design in the Characterization Stage: Interaction Diagrams: Description of goal, Defining UML Method, Operation, Object Interface, Class, Sequence Diagram, finding objects from Flow of Events, Describing the process of finding objects using a Sequence Diagram, Describing the process of finding objects using a Collaboration Diagram.

Learning Outcomes: After completion of this unit the student will be able to:

- understand the use case model of a system and factorize use cases into different component use cases. (L2)
- build the use case driven requirements for a particular system. (L3)
- utilize the sequence and collaboration diagram to find the objects. (L3)

UNIT III **8 L**

The Logical View Design Stage: The Static Structure Diagrams: The Class Diagram Model, Attributes descriptions, Operations descriptions, Connections descriptions in the Static Model, Association, Generalization, Aggregation, Dependency, Interfacing, Multiplicity.

Package Diagram Model:

Description of the model, White box, black box, Connections between packages.

Learning Outcomes: After completion of this unit the student will be able to

- explain the importance of class diagram. (L2)
- distinguish “is-a” and “has-a” relationship. (L4)
- identify and avoid common pitfalls with inheritance, and ways to express software behavior in UML. (L3)
- make use of the classes identified for a particular application to build package diagram to show the structure and dependencies between different modules. (L3)

UNIT IV **8 L**

Package Diagram Model: Interfaces, Create Package Diagram, Drill Down.

Dynamic Model: State Diagram / Activity Diagram: Description of the State Diagram, Events Handling, Description of the Activity Diagram, Exercise in State Machines.

Learning Outcomes: After completion of this unit the student will be able to:

- build activity diagrams for a given problem and develop the state chart diagram for a given class. (L3)
- present the transition from business events to use cases. (L2)
- identify, analyze the subsystems, various components and collaborate them interchangeably. (L3)

UNIT V **8 L**

Component Diagram Model: Physical Aspect, Logical Aspect, Connections and Dependencies, User face, Initial DB design in a UML environment.
Deployment Model: Processors, Connections, Components, Tasks, Thread, Signals and Events.

Learning Outcomes:

After completion of this unit the student will be able to

- model a component diagram by applying all the relevant standards, with realistic constraints. (L3)
- build an initial database design in a UML environment. (L6)
- test the hardware that will be used to implement the system and the links between different items of hardware. (L6).

Text Book(s):

1. Bernd Bruegge and Allen H. Dutoit, Object-Oriented Software Engineering: using UML, Patterns, and Java,3/e, Pearson Education India, 2013.

Reference Books:

1. Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides , Design Patterns: Elements of Reusable Object-Oriented Software,1/e, Pearson Education, 2015.

Course Outcomes:

After Completion of this course, the student will be able to

- possess an ability to practically apply knowledge software engineering methods, such as object-oriented analysis and design methods with a clear emphasis on UML. (L3)
- have a working ability and grasping attitude to design and conduct object-oriented analysis and design experiments using UML, as well as to analyze and evaluate their models. (L4)
- have a capacity to analyze and design software systems, components to meet desired needs. (L4)
- show an ability to form and work on multi-disciplinary teams that are able to perform multiple-faceted tasks from domain analysis and understanding to design and develop software systems based on object-oriented thinking. This may also provide an ability to communicate their models and solutions in an effective manner. (L3)
- display an ability to identify, formulate and solve software development problems: software requirements, specification (problem space), software design, and implementation (solution space). (L3)
- show an ability to use the graphical UML representation using tools such as IBM’s Rational Rose or Microsoft vision. (L4)

SOFTWARE DESIGN WITH UML Laboratory – Experiments

- Development of requirements specification, function oriented design using SA/SD, object-oriented design using UML, test case design, implementation using any OO language such as C++ and Java and testing. Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle for product development
- Sample Experimental case studies/projects to be implement by using UML concepts:

    a) Design and implement Online shopping system
    b) Design and implement E Library OPAC system
    c) Design and implement Bank ATM system
    d) Design and implement Hospital Management system
    e) Design and implement A point of sale (POS) system

19EID204: INTRODUCTION TO INNOVATION, IP MANAGEMENT & ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

Course Pre Requisite(s):

Good knowledge of Fundamentals of Management (Covered in Year 2, Semester 1)

The major emphasis of the course will be on creating a learning system through which management students can enhance their innovation and creative thinking skills, acquaint themselves with the special challenges of starting new ventures and use IPR as an effective tool to protect their innovations and intangible assets from exploitation.

Course Outcomes:

- Focus on various sources of Innovations.
- How to use external relationships with stakeholders of products and services
- Familiarize entrepreneurial entry strategies
- Present various financial facets of entrepreneurship
- Explain the role of IPR in protecting the innovations.

UNIT I **10 L**

Innovation: What and Why?

Innovation as a core business process, Sources of innovation, Knowledge push vs. need pull innovations.

Class Discussion- Is innovation manageable or just a random gambling activity?

Learning Outcomes:

After completion of this module, the student will be able to

- explain the process model of Innovation. (L2)
- list out and briefing the sources from where the innovations coming from. (L1)
- compare knowledge push with need pull innovations. (L4)
- how innovation makes the difference in corporate sector. (L1)

UNIT II **8 L**

Building an Innovative Organization

Creating new products and services, exploiting open innovation and collaboration, Use of innovation for starting a new venture

Class Discussion- Innovation: Co-operating across networks vs. ‘go-it-alone’ approach

Learning Outcomes:

After completion of this module, the student will be able to

- discover similarities and differences between developing products and services(L4)
- analyze the generic factors that influence product and service success and failure(L4)
- how firms use external relationships with all stakeholders of product and service development(L1)
- discuss the role of innovation in starting a new venture (L6)

UNIT III **8 L**

Entrepreneurship:

- Opportunity recognition and entry strategies
- Entrepreneurship as a Style of Management
- Maintaining Competitive Advantage- Use of IPR to protect Innovation

Learning Outcomes:

After completion of this module, the student will be able to

- discuss about various entrepreneurial entry strategies(L6)
- explain entrepreneurship as a style of management(L2)
- how IPR protect Innovations and give competitive advantage(L1)

UNIT IV **8 L**

Entrepreneurship- Financial Planning:

- Financial Projections and Valuation
- Stages of financing
- Debt, Venture Capital and other forms of Financing

Learning Outcomes:

After completion of this module, the student will be able to

- explain the financial projections for a startup(L2)
- discuss various stages of financing in venture capital(L6)
- how financial planning is important for entrepreneurship((L1)

UNIT V **8 L**

Intellectual Property Rights (IPR)
Introduction and the economics behind development of IPR: Business Perspective

- IPR in India – Genesis and Development
- International Context

- Concept of IP Management, Use in marketing

Types of Intellectual Property

- Patent- Procedure, Licensing and Assignment, Infringement and Penalty
- Trademark- Use in marketing, example of trademarks- Domain name
- Geographical Indications- What is GI, why protect them?
- Copyright- What is copyright
- Industrial Designs- What is design? How to protect?
- Class Discussion- Major Court battles regarding violation of patents between corporate companies

Learning Outcomes:

After completion of this module, the student will be able to

- distinguish various types of Intellectual property(L4)
- explain the concept of IP management in the Indian context(L1)
- discuss various provisions of IPRs for software industry(L6)

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.

Further, the topic for class discussion will be mentioned beforehand and students should be ready to discuss these topics (in groups) in class. Students are required to meet in groups before coming to class and prepare on the topic. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

Topic 1- Is innovation manageable or just a random gambling activity?

Topic 2- Innovation: Co-operating across networks vs. 'go-it-alone' approach

Topic 3- Major Court battles regarding violation of patents between corporate companies

Text Book(s):

1. Joe Tidd, John Bessant. Managing Innovation: Integrating Technological, Market and Organizational Change, Wiley, 2015.
2. Case Study Materials: To be distributed for class discussion.

Course Outcomes:

After the completion of the course, students will be able to

- take part in creative and innovative thinking styles(L5)
- investigate, understand and internalize the process of establishment of a startup(L6)
- learn to manage various types of IPR to protect competitive advantage (L3)

19EID236: DESIGN THINKING

L T P C
2 0 2 3

TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 1 Hr./Week	**Semester Examination: 50 marks**	**3**
Practical: 1 Hr. / Week	**Continuous Assessment: Yes**	
Activity: 1 Hr. / Week	**Term Work: 50 marks**	

	Leadership Oriented Learning (LOL)	
Nature of Course	Behavioral	
Pre requisites	Completion of all units from Semesters 1, 2, 3 and 4	
Course Terminal Objectives:		
1	Recognize the importance of DT	
2	Explain the phases in the DT process	
3	List the steps required to complete each phase in DT process	
4	Apply each phase in the DT process	
5	Use doodling and storytelling in presenting ideas and prototypes	
6	Create value proposition statements as part of their presentations	
7	Recognize how DT can help in functional work	
8	Recognize how Agile and DT complement each other to deliver customer satisfaction	

Course Enabling Objectives: **Upon completion of the course, students shall have ability to**		
1	Recognize the importance of Design Thinking	[U]
2	Identify the steps in the DT process	[C]
3	Recognize the steps in the empathize phase of DT	[C]
4	Identify the steps required to conduct an immersion activity	[C]
5	Conduct an immersion activity and fill up the DT question template	[AP]
6	Recognize the steps to create personas in the define phase of DT	[C]
7	Create personas in the define phase of DT	[AP]
8	Recognize the steps to create problem statements in the define phase of DT	[AP]
9	Define the problem statements in the define phase of DT	[E]
10	Recognize the steps in the ideate phase of DT	[C]
11	Apply the steps in the ideate phase of DT	[AP]
12	Recognize how doodling can help to express ideas	[U]
13	Recognize the importance storytelling in presenting ideas and protypes	[U]
14	Recognize the importance of the prototype phase in DT	[C]
15	Create a prototype	[AP]
16	Recognize the importance of service value proposition	[C]
17	Create a value proposition statement	[AP]
18	Recognize the best practices of the testing phase in DT	[U]
19	Test a prototype created through a DT process	[AP]
20	Recognize how DT can help in functional work	[E]
21	Recognize how Agile and DT complement each other to deliver customer satisfaction	[C]

Course Contents:	
Total Hours:	45 hours
Textbooks:	
	There are no prescribed texts for Semester 5 – there will be handouts and reference links shared.
Reference Books:	
1	Hooked by Nir Eyal
2	The Art of Creative Thinking by Rod Judkins
3	Start Up nation by Dan Senor and Saul singer

4	Start with Why by Simon Sinek
Web References:	
1	What is Design Thinking? Interaction Design Foundation
2	What are some of the good examples of design thinking? - Quora
3	Design thinking 101: Principles, Tools & Examples to transform your creative process
Online Resources:	
1	Understanding Design thinking WF NEN
2	Design Thinking and Innovation at Apple Wei Li
3	Stanford Webinar- Design Thinking = Method, Not Magic
4	Stanford Design Thinking Virtual Crash Course
5	So Many Uses- activity to spark creativity and design

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
	Apply	Defining problem statement	5
	Apply	Ideating solutions	5
	Apply	Creating a prototype	10

Summative Assessment based on End Semester Project

Bloom's Level		
Understand	Understand, Analyze, Apply	50
Apply		
Analyze	Conduct and apply DT in the project.	

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Recognize the importance of Design Thinking	2	**Why is Design Thinking important for business?** Stories and examples will be used to introduce Design Thinking to the participants. We will use relevant stories and the following videos. 1. YouTube video: The Design Thinking Process – Sprouts (3.57 mins) 2. Leverage TCS-provided DT content to show the evolution of DT and why is important in present business environment. Can be a video. (2 mins) Lecturer to encourage the students to maintain their Satori slam book and capture their learning points in it.	Introduction and discussion	60 mins
1	Recognize the importance of Design Thinking	2	**Why is Design Thinking important for you?** Experiential activity **Products that you loved and hated**: In this activity, learners will have to share about a product they like of disliked based on their experience. What would they need in a bad product to make it good?	Activity	90 mins
1	Identify the steps in the DT process	2	**What is DT?** Introduce the 5-Step Stanford Model using YouTube videos:	Lecture and demo	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			The video will give a brief idea about the five steps: • Empathize (search for rich stories and find some love) • Define (user need and insights – their POV) • Ideate (ideas, ideas, ideas) • Prototype (build to learn) • Test (show, don't tell) Start all over and iterate the flow as much as possible		
1	Recognize the steps in the empathize phase of DT	2	**What is empathy?** Touch the target activity (Recap from Sem 2 Unit 4) Discussions in class Reference: FHIL | Stages of Design Thinking | EMPATHY (2:29 mins)	Activity	60 mins
1	Identify the steps required to conduct an immersion activity	1 and 2	**How to empathize?** Moccasin Walk activity for 1 hour to allow learners experience stepping into the shoes of another person. *This is an individual activity.* Sharing observations with the group. Suggest that students try this even in their free time away from studies.	Activity and lecture	90 mins
1	Identify the steps required to conduct an immersion activity	1 and 2	**Intro to Immersion Activity** Introduction to immersion activity through flowcharts and handouts and examples (to be provided by TCS DT Team)	Lecture	45 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			(steps and the question template: 1. We met; 2. We were amazed to realize that; 3. We wonder if this means 4. It would change the world if)		
1	Conduct an immersion activity and fill up the DT question template	3	**Immersion activity** Participants will be divided into four groups. Each group will need to visit any one of the following places to conduct an immersion activity. They need to interview people and fill up the DT question template (explained in the last class) 1. College cafeteria 2. College library 3. College sports facility 4. Transport facility near college	Practical	180 mins
2	Recognize the steps to create personas in the define phase of DT Create personas in the define phase of DT	2 3	**Creating personas** Start with YouTube videos explaining the process of persona creation: 1. Personas – What is a persona and how do I create one? (2019) https://www.youtube.com/watch?v=GNvLpfXCge8 Each group will create at least one persona based on the immersion study they conducted in the empathize stage (refer to the four question	Lecture and practical	120 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			templates). The group can use A4 pages, colours and other props to create and display their respective persona. **Reference:** https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them Lecturer to guide participants on getting the personas right (based on guidelines provided by TCS DT Team).		
2	Recognize the steps to create problem statements in the define phase of DT	2	**Problem statements** Session will begin with YouTube videos on how to define problem statements in the Define phase. 1. FHIL | Stages of Design Thinking | REFRAME (1:55 mins) Lecturer will provide examples of problem statements in class (based on handouts provided by TCS DT Team)	Lecture and demo	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
2	Define the problem statements in the define phase of DT	3	**Defining problem statements** Group activity, in which each group will define the key problem statements (max three) for their lead personas. Each group will present while the remaining groups will do a peer review. Finally, lecturer will moderate/validate the problem statements (based on handouts provided by TCS DT Team)	Formative assessment	90 mins
3	Recognize the steps in the ideate phase of DT	1 and 2	**How to Ideate?** The session will start with YouTube videos: 1. FHIL | Stages of Design Thinking | IDEATE (1:54 secs) 2. What Is Six Thinking Hats? (Litmos Heroes) (1:58 secs) Lecturer to briefly tell them about the guidelines of ideating (to be provided by TCS DT Team)	Lecture and demo	60 mins
3	Apply the steps in the ideate phase of DT	3	**Ideation games** Game 1: Six Thinking Hats Game 2: Million-dollar idea	Activity	90 mins
3	Apply the steps in the ideate phase of DT	3	**Ideate to find solutions** Participants will work in their assigned groups to ideate solutions for the problem statements they identified (as continuation of immersion	Formative assessment	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			activity) applying ideation methods discussed in the previous session. They will get scores based on how well they can apply the ideation methods. Lecturers will observe the groups separately and assign them scores based on specific rubric (provided by the TCS DT Team).		
3	Recognize how doodling can help to express ideas	1	**Let's doodle!** Participants will first watch a video on doodling: Doodling – how it can help in presenting ideas during ideate and protype phases After that, participants will complete an activity on doodling.	Demo and activity	60 mins
3	Recognize the importance storytelling in presenting ideas and protypes	1	**What is Storytelling in DT?** Activity- Research to find out about people who have used DT in providing solutions. Present their findings in forms of stories. (Recap from Unit-Sem-) Suggested topics to be provided by the TCS DT team.	Activity	120 mins
4	Recognize the importance of the prototype phase in DT	2	**Why is a Prototype important in Design Thinking?** The session will start with an activity to drive home the importance of creating a prototype in the design thinking process. As part of debrief of the activity, lecturer will share	Activity and demo	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			relevant examples and prototyping guidelines (provided by the TCS DT Team). Finally, the participants will watch two YouTube videos: 1. FHIL | Stages of Design Thinking | PROTOTYPE 2. Prototyping Phase - Design Thinking | Coursera https://www.coursera.org/lecture/patient-safety-project-planning/prototyping-phase-jVuQn		
4	Create a prototype	3	**Prototype your idea** This is a group activity in which the participants will work in groups (created at the beginning of the course, in which they did immersion, persona creation, defining problem statement and ideating) to create prototypes based on the solutions they had identified. Lecturer to share feedback based on guidelines provided by the TCs DT team.	Formative assessment	180 mins
4	Recognize the importance of service value proposition Create a value proposition statement	2 3	**Value Proposition Statement** You Tube: What is Value Proposition (by Venture Well) (3:51 mins)? Lecturer to discuss the guidelines for creating a value	Lecture	120 mins 1635 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			proposition statement (to be provided by the TCS DT Team) Each group now needs to create value proposition statement for the solution they have suggested.		
4	Recognize the best practices of the testing phase in DT	1	**Testing in Design Thinking** Participants will first watch a YouTube video: FHIL | Stages of Design Thinking | TESTING After that lecturers will explain them the importance of Testing the prototype through stories (provided by the TCS DT Team). They will also explain how the loop works in DT between the Empathize and Testing phases.	Lecture	60 mins
	Test a prototype created through a DT process	3	**Test the Prototype** Each group needs to test their prototype created earlier and: 1. Document user feedback 2. Write down their inference from the feedback 3. Suggest next steps (the loop that happens in DT)	Activity	120 mins
4	Recognize how DT can help in functional work	1	**Role of DT in your work** Lecturer conducts a group/open house discussion on: "How DT can help me to become a better coder?"	Discussion	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Lecturer needs to capture the key learning points in these discussions.		
4	Recognize how Agile and DT complement each other to deliver customer satisfaction	1	Suggested session on: **How Agile and DT complement each other to deliver customer satisfaction**	Lecture	45 mins
4			**Share your Satori** Participants will be asked to share their Satori moments from the DT sessions	Reflection activity	60 mins
					33 hours
			Project **Option 1:** Each group needs to present a Prototype of how they can apply DT in their functional work or coding. Examples will be provided to explain what exactly they need to do. Option 2: Each group will apply DT to create a prototype to improve any existing product or service. For both options, groups need to complete all phases of the Stanford DT model and include the outputs of each phase in their presentation. Lecturers will evaluate the project based on the rubric provided by the TCS DT Team.		12 hours
				Total	**45 hours**

19EME236: OPERATIONS RESEARCH

L	T	P	C
2	0	2	3

This course is to aid decision making and improving efficiency of the system by applying advanced analytical methods. This course addresses a number of quantitative tools and techniques, and provides students with knowledge and skills needed to apply these tools and techniques for decision making in organizations.

Course objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Determine the least cost allocation / max profit allocation in case of transportation assignment problems.
- Construct the required activities in an efficient manner so as to complete it on or before a specified time limit and at the minimum cost.
- Develop mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
- Define the basics of simulation modelling and replicating the practical situations in organizations.

UNIT I **4 L**

Introduction to OR:
Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization, Phases of OR problem approach – problem formulation, building mathematical model, deriving solutions, validating model, controlling and implementing solution.

Learning Outcomes:

After completion of Module-I, the students will be able to:

- recognize the significance of Operations Research and mathematical modelling while analysing the practical problems in industry. (L1)
- formulate the various linear Programming Models. (L6)
- evaluate the optimal solution to simple linear programming problems. (L4)

UNIT II **12 L**

Linear Programming:
Linear programming– Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP.

Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence/Dependence of vectors, Rank, Basis, System of linear eqns., Hyper plane, Convex set, Convex polyhedron, Extreme points, Basic feasible solutions.

Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy &degeneracy, Sensitivity analysis.
Simplex Algorithm – slack, surplus & artificial variables, computational details, Big-M method, identification and resolution of special cases through simplex iterations.
Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.

Learning Outcomes:

After completion of Module-I, the students will be able to:

- formulate the various linear Programming Models. (L6)
- evaluate the optimal solution to simple linear programming problems. (L4)
- develop the mathematical models and propose the optimal resource allocation. (L6)

UNIT III **10 L**

Transportation and Assignment problems:
TP - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution.
AP - Examples, Definitions – decision variables, constraints, formulation, Balanced &unbalanced situations, Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution.

Learning Outcomes:

After completion of Module-II, the students will be able to:

- formulate the linear programming problem as a Transportation model. (L6)
- formulate the linear programming problem as an Assignment model. (L6)
- evaluate the optimal solution to Transportation Problems. (L4)
- evaluate the optimal solution to Assignment Problems. (L4)

UNIT IV **10 L**

PERT – CPM:
Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles, Concept of project crashing/time-cost trade-off.

Inventory Control:
Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ &Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known/unknown stock out situations, models under prescribed policy, Probabilistic situations.

Learning Outcomes:

After completion of Module-V, the students will be able to:

- recognize the significance of Inventory models & Project Management in real world industrial scenarios. (L1)
- differentiate between the critical and non-critical activities of a given project. (L4)
- propose the optimal schedule of the activities involved in a project. (L6)
- evaluate the optimal order/batch quantity for minimum inventory cost. (L4)

UNIT V **10 L**

Queuing Theory:
Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase).
Kendall's notation, Little's law, steady state behaviour, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief description about some special models.

Simulation Methodology:
Definition and steps of simulation, random number, random number generator, Discrete Event System Simulation – clock, event list, Application in Scheduling, Queuing systems and Inventory systems.

Learning Outcomes:

After completion of Module-III, the students will be able to:

- define the various queuing models. (L1)
- calculate Queue length & waiting time of a given queue system. (L3)
- evaluate the optimal sequence of the jobs on machines for minimum cycle time. (L4)
- develop simulation model using heuristic methods. (L3)

Text Book(s):

1. H.A. Taha, Operations Research: An Introduction,10/e, Pearson,2017.

Reference Books:

1. K.G. Murthy, Linear Programming, revised edition, Wiley, 1983.
2. G. Hadley, Linear Programming., Narosa,2002.

3. H.M. Wagner, Principles of OR with Application to Managerial Decisions, 2/e, Prentice Hall India Learning Private Limited, 1980.
4. F.S. Hiller and G.J. Lieberman, Introduction to Operations Research, 10/e, McGraw Hill, 2017.
5. Thomas L. Saaty, Elements of Queuing Theory, New Ed edition, Dover Pubns, October 1, 1983.
6. A. Ravi Ravindran, Operations Research and Management Science, Hand Book, 1/e, CRC Press, 2008.
7. Wiest & Levy, Management Guide to PERT/CPM, 2/e, Prentice Hall India Learning Private Limited, 1979.
8. J.W. Prichard and R.H. Eagle, Modern Inventory Management, Wiley & Sons, 1965.

Course Outcomes:

The student should be able to:

- appreciate the wide applicability of operations research technology from agriculture to defense, covering almost all domains of science, arts, commerce and technology. (L5)

- build the optimum solution for numerous problems of operations research by systematic defining, formulating, analyzing, developing an optimum solution and further refining the solution using simplex method. (L3)

- obtain optimum cost /profit by the application of transportation algorithm. (L4)

- develop minimum cost and maximum profit solutions to Assignment and Travelling salesman problems. Optimize the project duration and cost using PERT/CPM techniques. (L6)

- provide probabilistic and heuristic solutions for real life problems using the Queuing and Simulation models. (L6)

OPEARTIONS RESEARCH LABORATORY

Course objectives:

- Develop mathematical formulation for linear programming and transportation problem
- Define Queuing system and their characteristics.
- Construct the required activities in an efficient manner so as to complete it on or before a specified time limit and at the minimum cost.
- Develop mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.

List of Experiments

Introduction to Operations Research Packages - using Solver/Excel and TORA/Statistical Packages

1. Decision Modeling

- Linear programming
- Networks Analysis
- Waiting Lines.

2. Production management:

- Inventory
- Scheduling.
- Simulation models.

3. Exercise on application of Operations Research Models to various sector of economy including

- Manufacturing
- Health Care
- Infrastructure
- Insurance
- Banking
- Retail
- Agriculture and Governance

Course Outcomes:

After the successful completion of the course, the students will be able to

- apply the models to incorporate rational decision making process in real life situations. (L3)
- analyse various modeling alternatives & select appropriate modeling techniques for a given situation. (L4)
- validate output from model to check feasibility of implementations. (L4)
- create innovative modeling frameworks for a given situation. (L6)

19EMC282: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

L	T	P	C
2	0	0	0

Course objectives:

- The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.
- Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
- The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

Course Content:

Basic Structure of Indian Knowledge System (i) Veda (ii) upaveda (Ayurveda, Dhanurveda, GandharvaVeda,ShilpaVeda,ArthaVeda)(iii)Vedang(ShiskhaKalpaVyakarna,Nirukta,Chhanda,Jyotisha, (iv) Unaiga (Dharma,Sastra,Meemamsa,Purana,tarakasaastra)

Modern Science and Indian Knowledge System

Yoga and Holistic Health care

Case Studies.

Course Outcomes:

- ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective. (L2)

Text/Reference Books

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, 5th Edition, Bharatiya Vidya Bhavan, Mumbai, 2014.
2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan, 2012.
3. Fritzof Capra, Tao of Physics, 3/e, 2007.
4. Fritzof Capra, The wave of Life.
5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am.
6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.
7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi, 2016.
8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016.

Semester V

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB331	Design and Analysis of Algorithms	PC	3	0	4	5
2	19ECB333	Compiler Design	PC	3	0	4	5
3	19EID303	Fundamentals of Management	MS	2	0	0	2
4	19EID305	Business Strategy	MS	2	0	0	2
5	19EHS303	Business Communication & Value Science III	HS	2	0	0	2
6	19ECB34X	Elective I	PE	2	1	2	4
7	19ECB391	Mini Project	PW	0	0	2	1
Total				**21**			

19ECB331: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	C
3	0	4	5

This course introduces the student design and analysis of algorithms. This enables the students to understand and implement the various techniques of designing the algorithms, determine the efficiency of various algorithms in terms of time and space complexities. It illustrates the computability of algorithms NP, NP-complete, NP-hard and beyond NP. The insights and knowledge gained can be applied to the recent technologies.

Course objectives:

- Familiarize the student with asymptotic analysis, performance of algorithm
- Enable the student to analyze various techniques of designing an algorithm
- Familiarize the student with the concepts, graph and tree traversals
- Introduce the computability of algorithms
- Introduce the concepts of beyond NP

UNIT I **8 L**

Introduction: Characteristics of Algorithm, Analysis of Algorithm- Asymptotic analysis of Complexity Bounds, Best, Average and Worst Case behavior, Performance Measurements of Algorithm, Time and Space Trade-Offs, Analysis of Recursive Algorithms through Recurrence Relations- Substitution Method, Recursion Tree Method, and master's Theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the Big-O, Omega and Theta notations. (L2)
- analyze an algorithm in terms of its time and space complexities. (L4)
- analyze various recursive algorithms through recurrence relation. (L4)

UNIT II **8 L**

Fundamental Algorithmic Strategies: Brute-Force, Heuristics, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies, Illustrations of these techniques for Problem Solving, Bin Packing, Knapsack, Travelling Salesman Problem.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the concepts of designing algorithms (L2)
- analyze various techniques of designing algorithms (L4)
- solve knapsack and travelling salesman algorithms (L3)

UNIT III **8 L**

Graph and Tree Algorithms: Traversal algorithms- Depth First Search (DFS) and Breadth First Search (BFS), Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the concepts of graphs and trees (L2)
- illustrate various graph and tree traversals. (L3)
- determine the shortest path and minimum spanning trees (L5)

UNIT IV **8 L**

Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems, and Reduction techniques.

Learning Outcomes:

At the end of this unit, the student will be able to

- illustrate the computability of algorithms (L2)
- classify various computability of classes (L4)
- summarize NP, NP complete, NP hard theorems and techniques (L4)

UNIT V **10 L**

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE, Introduction to Quantum Algorithms.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the beyond NP concepts (L2)
- compare different types of approximation and randomized algorithms (L4)
- illustrate the concept of quantum algorithms (L2)

Course Outcomes:

After the completion of this course, the student will be able to

- interpret the best, average, worst case behavior of algorithm (L2)
- determine the time complexity of algorithms (L5)
- illustrate and compare the various techniques of designing algorithms (L2)
- solve various algorithmic designs, graph, and tree algorithms (L3)
- contrast NP, NP complete and NP hard concepts (L2)

DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY

List of Practical Experiments:

- Bin packing algorithm
- Knapsack problem using greedy method
- Travelling salesman problem using dynamic programming
- Binary Tree traversals
- Graph traversals
- Dijkstras shortest path algorithm
- Prims and kruskals minimum spanning tree algorithms
- Topological sorting
- Network flow algorithm

Text Book(s)

1. E. Horowitz and S. Sahni, Fundamental of Computer Algorithms.
2. A. Aho, J. Hopcroft and J. Ullman, The Design and Analysis of Computer Algorithms.

Reference Books:

1. T. H. Cormen, C. E. Leiserson and R. L. Rivest, Introduction to Algorithms.
2. S. Baase, D. E. Knuth, The Art of Computer Programming, Vol. 1, Vol. 2 and Vol. 3
3. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information.

19ECB333: COMPILER DESIGN

L	T	P	C
3	0	4	5

Compilers play a major role in fulfilling user's computing requirements, used to translate high level language to machine understandable form. This course enables the students to gain knowledge on various phases involved in designing a compiler.

Course objectives:

- Explore the basic techniques that underlie the principles, algorithms and data structures that are involved in the Compiler Construction.
- gain experience in using automated tools that helps in transforming various phases of the compiler

UNIT I **8L**

Introduction: Phases of compilation and overview. Lexical Analysis (scanner): Regular languages, finite automata, regular expressions, relating regular expressions and finite automata, scanner generator (lex, flex).

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze various phases involved in the design of compiler construction (L1)
- compare methods involved in constructing the compiler (L1)
- learn how regular expressions helps to design Lexical Analysis phase (L1)
- explore how LEX Tool simplifies the design of Lexical Analysis phase (L2)

UNIT II **8L**

Syntax Analysis (Parser): Context-free languages and grammars, push-down automata, LL(1) grammars and top-down parsing, operator grammars, LR(0), SLR(1), LR(1), LALR(1) grammars and bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison)

Learning Outcomes:

At the end of this unit, the student will be able to

- classify the possible ways in designing Syntax Analysis Phase (L1)
- address the difficulties in top-down parsers (L1)
- analyze the issues involved in designing efficient Top-Down (LL) parser (L2)
- explore the deficiencies in the design basic Bottom-Up parsers (L1)
- Design various bottom up parsers (L3)

UNIT III **10L**

Semantic Analysis: Attribute grammars, syntax directed definition, evaluation and flow of attribute in a syntax tree.

Symbol Table: Basic structure, symbol attributes and management. Run-time environment: Procedure activation, parameter passing, value return, memory allocation, scope.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the notational framework of Syntax Directed Definitions (L2)
- design Syntax Directed Definitions to generate intermediate code (L3)
- identify the issues involved in the Run-Time storage administration (L3)

UNIT IV **8L**

Intermediate Code Generation: Translation of different language features, different types of intermediate forms.

Code Improvement (optimization): control-flow, data-flow dependence etc.; local optimization, global optimization, loop optimization, peep-hole optimization etc.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the different types of code improvement techniques (L2)
- illustrate various technique to store three address statements (L3)
- understand different types of intermediate forms (L2)

UNIT V **10L**

Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization (for cache memory) etc. Register allocation and target code generation.

Advanced topics: Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify issues involved in the machine independent code optimization (L3)
- illustrate loop optimization with suitable examples (L3)
- understands the compilation of object oriented and non-imperative programming language (L4)
- explore techniques involved in obtaining the final code, register allocation and assignment (L4)

Course Outcomes:

At the end of the course the student will be able to

- define and analyze various phases involved in designing a compiler(L1)
- compare and contrast between bottom-up and top-down parsing techniques(L2)
- illustrate the usage of Syntax Directed Definition in generating intermediate code(L3)
- identify various machine independent optimization techniques(L4)
- explore techniques involved in obtaining the final code(L4)

COMPILER DESIGN LABORATORY

Assignments using Lex and Yaac

Text Book(s):

1. V. Aho, R. Sethi and J. Ullman, Compilers: Principles, Techniques and Tools.
2. Levine R. John, Tony Mason and Doug Brown, Lex &Yacc.

Reference Books:

1. Bjarne Stroustrup, The Design and Evolution of C++.

19EID303: FUNDAMENTALS OF MANAGEMENT

L	T	P	C
2	0	0	2

This course will teach students the management theories, evolution of management over the years and few basic concepts without going into the details. After studying this course the students will develop an understanding about how organizations work and find it easier to grasp the intricacies of other management areas such as finance, marketing, strategy etc. which will be taken up in future terms.

Course objectives:

- To demonstrate the relevance knowledge and evolution of management thought
- To describe the effective management of planning, organizing, directing, and controlling related to the internal and external environment.
- To learn various organizational behavioural aspects
- To understand the importance of structure and types and organization in the field of Management.
- To learn issues of ethics and social responsibility of managers
- To demonstrate an understanding of leadership concepts in an organization.

UNIT I **7 L**

Management Theories: Introduction to Management: nature, scope, purpose, importance and functions of management; Management as an art, science & profession; Managers at work place: who are managers and where do managers work? (Levels of management); Why are managers work? What do managers do? (Management functions, process & roles); Management Vs Administration; Management history: early management, Classical approach (scientific & general administrative theories), behavioral approach, Quantitative approach, Contemporary approaches. Social Responsibility of Managers.

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate the relevant knowledge in management (L3)
- understand the evolution of Management thought (L2)

UNIT II **7 L**

Planning work activities: What is planning? Nature of planning, why do managers plan? Type plans; Management by objectives); Planning process and premises; decision making process, approaches to decision making, types of decision, and decision making conditions, decision making biases and errors.

Organizational Design: Designing organizational structure: meaning of organizing, organization and organizational design; six elements of organizational design (Work specialization, departmentalization, chain of command, span of control, centralization and decentralization, Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure, and team structure). Staffing: meaning, importance and process.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the importance and role of planning function in management (L2)
- analyse and make effective decisions in different conditions (L4)
- understand the important elements of organisational design (L2)
- design effective organizational structures suitable for different businesses (L3)

UNIT III **7 L**

Directing: meaning, nature, scope and importance of directing, elements of directing (supervision, motivation, leadership, communication); Leadership: nature and importance, leadership Vs management; Trait, behavioral and contingency approaches to leadership; Leadership styles.

Controlling: meaning, nature and importance, the control process, and techniques of controlling, tools for controlling organizational performance (feedforward, concurrent, and feedback controls, financial controls, information controls, the balanced scorecard, benchmarking).

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the concept of directing and its importance (L2)
- understand and Assess leadership qualities required to perform managerial activities (L2, L3)
- understand controlling as an important function to meet the standards and its techniques (L2)

UNIT IV **5 L**

Organization Behaviour: Introduction, Personality, Perception, Learning and Reinforcement, Motivation, Group Dynamics, Power & Influence, Work Stress and Stress Management, Managing Cultural Diversity.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the various important elements of organizational behaviour (L2)
- understand the concept of motivation and group dynamics (L2)

UNIT V **4 L**

Managerial Ethics: Ethics and Business, Ethics of Marketing & advertising, Ethics of Finance & Accounting, Business and Social Responsibility, International Standards, Corporate Governance, Corporate Citizenship, Corporate Social Responsibility.

Learning Outcomes:

At the end of this unit, the student will be able to

- assess the ethics of management practices (L2)
- examine social responsibility of organizations (L3)

Course Outcomes:

On successful completion of this course, students will be able to**:**

- understand theoretical aspects, process and principles, scope of management(L2)
- analyze how the field of management has evolved and its major contributions(L4)
- analyze and apply critical role of managers in modern organizational settings(L3 & L4)
- illustrate and evaluate the importance of planning, organizing, directing and controlling in decision making(L4 & L5)

Home Assignments:

The topic for class discussion will be mentioned beforehand and students should be ready to discuss these topics (in groups) in class. Students are required to meet in groups before coming to class and prepare on the topic. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Corporate social responsibility (CSR) and HRM implications: What does it mean to be socially responsible within an increasingly financially driven market economy?
2. Topic: Leaders are Born, Not Made! The debate

Text Books:

1. Richard L. Daft, Understanding the Theory and Design of Organizations

Reference Books:

1. Robbins, S. P., & Coulter, M. (2018). Management 14e. Pearson India.
2. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behavior

19EID305: BUSINESS STRATEGY

L	T	P	C
2	0	0	2

This course familiarizes the student with the concept of strategic management and presents the various schools of thoughts and perspectives of the subject. Recognizing a firm's intellectual assets in core competencies and applying the processes and capabilities-based approach to strategy is emphasized in this course. Methods of industry and competitor analysis and details on generic strategies are provided to enable the learner to understand the formulation of competitive strategies. Various corporate strategies for organizational growth and sustenance are also presented. The value of effective strategic control systems and the role of corporate governance mechanisms in strategy implementation are highlighted.

Course objectives:

- Familiarize the student with various schools of thoughts and perspectives of strategic management.
- Enable the student to analyze the internal environment of the firm viz. intellectual assets.
- Present the student with tools to analyze the industry and competitors to arrive at the formulation of generic strategies.
- Recognize various corporate strategies for organizational growth and sustenance.
- Realize the role of strategic control and corporate governance in strategy implementation.

UNIT I **5 L**

Introduction to Strategic Management: Importance of Strategic Management – Vision and Objectives – Schools of thought in Strategic Management – Strategy Content, Process, and Practice – Fit Concept and Configuration Perspective in Strategic Management

Learning Outcomes:

At the end of this unit, the student will be able to

- describe strategic management, and specify the need of vision and objectives (L1, L2)
- explain various schools of thought and perspectives of strategic management (L4)

UNIT II **5 L**

Internal Environment of Firm-Recognizing a Firm's Intellectual Assets: Core Competence as the Root of Competitive Advantage – Sources of Sustained Competitive Advantage – Business Processes and Capabilities-based Approach to Strategy

Learning Outcomes:

At the end of this unit, the student will be able to

- present core competence as a basis for competitive advantage (L3)
- discover the sources of Sustainable Competitive Advantage (L3)
- apply the processes and capabilities-based approach to strategy (L3)

UNIT III **7 L**

External Environments of Firm-Competitive Strategy: Five Forces of Industry Attractiveness that Shape Strategy – The concept of Strategic Groups, and Industry Life Cycle – Generic Strategies – Generic Strategies and the Value Chain

Learning Outcomes:

At the end of this unit, the student will be able to

- determine the industry attractiveness using five forces and industry life cycle models (L3)
- appraise the position of the competitors through strategic groups (L4)
- formulate generic strategies under various competitive conditions and to illustrate how value chain can help achieve competitive advantage. (L3, L4)

UNIT IV **7 L**

Corporate Strategy, and Growth Strategies: The Motive for Diversification – Related and Unrelated Diversification – Business Portfolio Analysis – Expansion, Integration and Diversification – Strategic Alliances, Joint Ventures, and Mergers & Acquisitions

Learning Outcomes:

At the end of this unit, the student will be able to

- examine the need for diversification and describe its classification (L1, L2)
- apply the tools of portfolio analysis (L3)
- assess various corporate strategies for organizational growth and sustenance. (L5)

UNIT V **6 L**

Strategy Implementation: Structure and Systems: The 7S Framework – Strategic Control and Corporate Governance

Learning Outcomes:

At the end of this unit, the student will be able to

- perform internal analysis using 7S framework to identify if the elements are effectively aligned and allow organization to achieve its objectives. (L3)
- explain the value of effective strategic control systems in strategy implementation and the role of corporate governance mechanisms in ensuring that the interests of the stakeholders are aligned. (L4)

Course Outcomes:

After the completion of this course, the student will be able to

- learn the fundamental concepts of strategic management to analyze business situations and apply these concepts to solve business problems. (L1, L3, L4)

- understand the fundamental principles of and interrelationships among business functions such as: R&D, production, marketing, finance, HR and information technology. (L2)
- understand the inter-relationships of business to individuals, other organizations, government and society. (L2)
- analyze complex, unstructured qualitative and quantitative problems, using appropriate tools. (L4)

Home Assignment:

- Latest business events would be discussed in class and students should be ready to discuss these events (in groups). The topic will be mentioned beforehand. Students are required to meet in groups before coming to class and prepare on the topic.

- There will be periodic homework assignments relating to the course concepts or mini-cases. Specific instructions will be given separately.

Final Project:

Students (in groups) are required to work on a project and submit the project report and deliver presentation. The topic of the project will be given later.

Text Book:

1. Robert M. Grant (2012). Contemporary Strategic Management, Blackwell, 7th Edition.

Reference Books:

1. M.E. Porter, Competitive Strategy, 1980.M.E. Porter,
2. Competitive Advantage, 1985 Richard Rumelt (2011).

Good Strategy Bad Strategy: The Difference and Why It Matters.

19EHS303: BUSINESS COMMUNICATION & VALUE SCIENCE III

L	T	P	C
2	0	0	2

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 2.5 Hrs./Week	Semester Examination: 50 marks	2
Practical: 1.5 Hrs. / Week	Continuous Assessment: Yes	
Lab: 2 Hrs. / Week	Term Work: 50 marks	

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of English (verbal and written) Completion of all units from Semesters 1, 2 and 3

Course objectives:

1	Develop technical writing skills
2	Introduce students to Self-analysis techniques like SWOT & TOWS
3	Introduce students to key concepts of: a) Pluralism & cultural spaces b) Cross-cultural communication c) Science of Nation building

Course Outcomes:

Upon completion of the course, students shall have ability to

C2.6.1	Apply & analyze the basic principles of SWOT & life positions.	[U]
C2.6.2	Understand, analyze & leverage the power of motivation in real life	[AP]
C2.6.3	Identify & respect pluralism in cultural spaces	[AP]
C2.6.4	Understand and apply the concepts of Global, glocal and translocational	[C]
C2.6.5	Analyze cross cultural communication	[U]
C2.6.6	Apply the science of Nation building	[AP]
C2.6.7	Identify the common mistakes made in cross-cultural communication	[E]
C2.6.8	Understand, apply & analyze the tools of technical writing	[U]
C2.6.9	Recognize the roles and relations of different genders.	[AP]
C2.6.10	Understand Artificial intelligence &recognize its impact in daily life	[U]
C2.6.11	Identify the best practices of technical writing	[AP]
C2.6.12	Differentiate between the diverse culture of India	[E]

Course Contents:

Objectives for Semester 4

After completing this semester, learners will be able to:

- Summarize the basic principles of SWOT and Life Positions.
- Apply SWOT in real life scenarios.
- Recognize how motivation helps real life.
- Leverage motivation in real-life scenarios.
- Identify pluralism in cultural spaces.
- Respect pluralism in cultural spaces.
- Differentiate between the different cultures of India.
- Define the terms global, glocal and translocational.
- Differentiate between global, glocal and translocational culture.
- Recognize the implications of cross-cultural communication.
- Identify the common mistakes made in cross-cultural communication.
- Apply cross-cultural communication.
- Differentiate between the roles and relations of different genders.
- Summarize the role of science in nation building.
- Define AI (artificial intelligence).
- Recognize the importance of AI.
- Identify the best practices of technical writing.
- Apply technical writing in real-life scenarios.

Total Hours:	48 hours

Text Books:

	There are no prescribed texts for Semester 4 – there will be handouts and reference links shared.

Web References:

1	Examples of Technical Writing for Students https://freelance-writing.lovetoknow.com/kinds-technical-writing
2	11 Skills of a Good Technical Writer https://clickhelp.com/clickhelp-technical-writing-blog/11-skills-of-a-good-technical-writer/
3	13 benefits and challenges of cultural diversity in the workplace https://www.hult.edu/blog/benefits-challenges-cultural-diversity-workplace/

Online Resources:

1	https://youtu.be/CsaTslhSDI

2	https://m.youtube.com/watch?feature=youtu.be&v=IIKvV8_T95M
3	https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y
4	https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be
5	https://m.youtube.com/watch?v=7sLLEdBgYYY&feature=youtu.be

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C1.6.1	Analyze	SWOT in real life	5
C1.6.2	Analyze	Motivation in real life	4
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand	Written Assessment, project and group discussion		50
Apply			
Analyze			

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Guest lecture by a renowned personality to kick start this semester.	This will be outside the total hours for this Semester	**90 mins**
1			REUNION Recap activity on the earlier learning after a 6 months break. If we can flash the projects they completed in the last semester…… End with a Quiz in multiple format rounds testing the objectives.	Activity	60 Minutes
1	**Summarize the basic principles of SWOT and Life Positions.**	2	SWOT and Life Positions Meet Dananjaya: Meet Dananjaya Hettiarachchi The World Champion of Public Speaking 2014 who made the winning speech which was rated amongst the "Most talked-about speeches of	Lecture and activity	60 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			2014". https://www.youtube.com/watch?v=bbz2boNSeL0&t=24s Debrief on the video. How it relates to SWOT. **Intro activity**: Give story of an individual* and divide people into 4 groups S W O T and ask them to jot down the SWOT. Start with a different nomenclature (demystifying SWOT)		
1	Apply SWOT in real life scenarios.	3	Pat your back activity…strength will be written by others other points by you Create your SWOT	Practical	60 Minutes
1	Apply SWOT in real life scenarios.	3	SWOT Vs. TOWS The Balancing Act Ted talk on biomimicry: (Only first 8 mins): https://www.youtube.com/watch?v=RHrO4t86phA Debrief on the Ted talk in which the facilitator gently guides the group towards the understanding that survival happens only when we seek ideas from the external world to turn the threat into opportunity Research on TOWS and find out how you can turn your threat into opportunity. Two people mutually identifying opportunities from each other's threats.	Lab	120 minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Apply SWOT in real life scenarios.	3	Presentation on what are the strengths they have identified to survive in the VUCA World. Group presentations of 10 mins each.	Formative evaluation	90 mins
1	Recognize how motivation helps real life.	1	Motivation Stories YouTube videos on Maslow's Theory	Lecture and activity	90 mins
1	Leverage motivation in real-life scenarios.	3	Scenario based activity on identifying and leveraging motivation	Formative evaluation/Lab	60 mins
1	Recognize how motivation helps real life.	1	Present their findings and approaches as groups. They need to explain the idea of motivation with the help of examples.	Practical	60 mins
Unit 2					
2	Identify pluralism in cultural spaces.	1	Rivers of India a. Divide participants into groups of 5. Each group should assign themselves a name from the Indian Rivers. These groups will continue throughout this Unit. b. Learn and Exchange Group activity in which participants need to learn the following four greetings of a state (different from their own) and exchange it with another group: • Good morning • Thank you • Sorry • Good night Indicative only	Activity	90 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
2	Identify pluralism in cultural spaces. Respect pluralism in cultural spaces.	2 3	a. Awareness and respect for pluralism in cultural spaces b. Announce the Rhythms of India activity to be held in the next session. The rules of the activity will be detailed at this point. Teams to prepare for the performance beyond class hours.	Theory/Discussion using Phir Miley Sur Mera Tumhara	90 Minutes
2	Differentiate between the different cultures of India.	2	Rhythms of India (Cultures in India) Group activity: Each group to perform a short dance piece (3 mins) from any of the Indian states (to be decided by lots). They have to present the background and unique features of the dance form (5 min).	Practical/Discussion	120 Minutes
2	• Define the terms global, glocal and translocational. • Differentiate between global, glocal and translocational culture.	1, 2	a. Global, glocal, translocational Use Ted and YouTube videos to show examples b. Announce debate to be held in the next session. They have to come prepared for the debate/discussion.	Lecture/Discussion	60 mins
2	Differentiate between global, glocal and translocational culture.	2	Debate on Global, glocal, tanslocational impacts (topics to be decided by the faculty or suggested by the students). Debate to be held in the presence of an external moderator. Eight groups will get four topics to debate upon.	Activity	60 mins
2	• Recognize the implications of cross-cultural communication. • Identify the common mistakes made	1, 2	Cross-cultural communication A. Verbal and non-verbal communication (approach is through videos). Point out the obvious mistakes. From our perspective…how anyone would feel if someone else made mistakes	Lecture/Discussion	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	in cross-cultural communication.		about our cultures. B. Let participants have a group discussion on the implications of cross cultural communication.		
2	Apply cross cultural communication.	3	Suggested long-term activity: A VR game in which learners can visit different locations of the world and overcome challenges by using cross cultural skills.		
2	Identify the common mistakes made in cross-cultural communication	2	Culture shock Group activity to perform skits based on situations provided by the lecturer.	Practical	60 mins
2	Differentiate between the roles and relations of different genders.	2	Gender awareness Participants will view relevant scenarios in the class and then participate in a reflection activity in group. The scenarios can be presented using an Augmented Reality intervention.	Discussion	90 mins
2	Differentiate between the roles and relations of different genders.	2	Gender awareness campaign Groups to present the detailed plan of Gender awareness campaigns with four different themes. • College • Workplace • Family • Friends	Activity	60 mins
2			Quiz Time	Summative Evaluation for Unit	60 Minutes
Unit 3					
3	Summarize the role of science in nation building.	2	Role of science in nation building Introduce the topic and discuss the role of scientists and mathematicians from ancient India. Break the students into	Theory and lab	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			groups and give them ten minutes to access internet and get information about ten eminent scientists and mathematicians of ancient India. Groups will be given five minutes to present on the next day. Groups will also frame two questions which they will ask after presenting. This can also be taught through Augmented Reality, where images of the scientists will be put up around the class and they will be able to gather the information by using their phones and AR app.		
			Groups present their findings. Other groups note down their learning. At the end there will be a quiz to assess their learning.	Activity	90 mins
	Summarize the role of science in nation building.	2	Role of science post-independence Groups to present using multiple formats on any one of the four given topics. • Inventions • Inventors • Institutes • Information technology	Lab and practical	120 mins
	Identify the best practices of technical writing.	1	Introduction to technical writing Basic rules of technical writing through examples.	Lecture (Guest faculty, over webinar)	60 mins
	Identify the best practices of technical writing.	1	Practice activity on technical writing.	Lab	60 mins
	Apply technical	3	Assessment on technical	Summative	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	writing in real-life scenarios.		writing on the following topic: Explain the following to a visually impaired person: • DNA • Rings of Saturn • Structure of an oxygen atom • Structure of heart	evaluation	
Unit 4					
4	Define AI (artificial intelligence).	1	"Voice of the Future" Activity How will a voice assistant evolve in 25 years from now? Each group will present a skit.	Activity	90 mins
	Recognize the importance of AI.	1	AI in Everyday Life Discussion in groups on given topics and then cross sharing of discussion points amongst the groups.	Lab and Activity	90 mins
	Recognize the importance of AI.	1	Design your college in the year 2090 Groups need to create the college of future with the future teachers, teaching methods, types of students, etc. We will end the session with the question: How will offices/workplaces change in future? Who do you think would be your colleagues?	Lab and Practical	90 mins
	Recognize the importance of AI.	1	Communicating with machines Theory and Ted talk videos	Lecture	60 mins
	Recognize the importance of AI.	1	Debate in the presence of an external moderator. Will machines control us in future?	Discussion	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Identify the best practices of technical writing.	1	Applying technical writing in profession Theory with YouTube and Dr Bimal Ray's videos. Dr Bimal Kumar Roy, a former Director of the Indian Statistical Institute, is a cryptologist from the Cryptology Research Group of the Applied Statistics Unit of ISI, Kolkata.	Lecture	90 mins
	Apply technical writing in real-life scenarios.	3	Scenario-based Assessment on technical writing Each group will make a presentation on the following: a) Sell Analytics and Insight to the local tea seller. b) Explain the concept of Cloud to your 87 year old grandmother. c) Introduce the concept of friendly robots to a class 3 kid. Explain IOT to your helping hand at home	Summative evaluation	60 mins
Project					
			Visit rural area/ underprivileged parts of city to address some of the local issues; if relevant, suggest a practical technology solution to the issues.	Project	10 hours

19ECB341: CONVERSATIONAL SYSTEMS

L	T	P	C
2	1	2	4

About the technology *- Ever-increasing customer expectations (emotional connect, 24x7 availability, real-time responses, enterprise presence in their preferred platform or channel), changing preferences, and demand for personalized services - Hence Conversational Experiences will use the right mix of multi-modal experience involving – NLP, Speech, Multi-media, Vision, Virtual reality – for better and personalized results of Customer acquisition, retention, and revenue.*

Current market demand *- According to the recently updated International Data Corporation (IDC) Worldwide Artificial Intelligence Systems Spending Guide, spending on AI systems will reach $97.9 billion in 2023, more than two and one-half times the $37.5 billion will be spent in 2019. The compound annual growth rate (CAGR) for the 2018-2023 forecast period will be 28.4 %.(https://www.idc.com/getdoc.jsp?containerId=prUS45481219). Globally vendors of Consumer devices – phones, speakers, displays, wearables – are competing and investing billions to make them feature-rich, more powerful, connected, and affordable.*

Course objectives:

- To provide a foundation on different concepts of Artificial Intelligence and Basic Python programming concepts.
- To investigate various applications of AI such as Virtual Assistants,
- Enable attendees to acquire knowledge on chatbots and their terminologies
- Work with ML Concepts and different algorithms to build custom ML Model
- Better understand Conversational experiences and provide better customer experiences

UNIT I **8L**

Fundamentals of Conversational Systems- Introduction: Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI.
Underlying technologies: Natural Language Processing, Artificial Intelligence, Machine Learning, NLG, Speech-To-Text, Text-To-Speech, Computer Vision, etc.
Introduction to Top players in Market – Google, MS, Amazon &Market trends.
Messaging Platforms (Facebook, WhatsApp) and Smart speakers – Alexa, Google Home, and other new channels. **Ethical and Legal Considerations in AI Overview.**
Foundational Blocks for Programming -Basic Python programming concepts, Node Basics, Coding Best Practices, Evaluation Test (Hands-On).
Learning Outcomes:
After completion of this unit, the student will be able to

- recognize various domains in which AI can be applied(L2)
- describe natural language processing and concepts for converting speech to different
- forms(L2)
- understand various messaging platforms and their ethical and legal considerations. (L2)
- understand the basic programming concepts. (L2)

UNIT II **8L**

Natural Language Processing - Introduction: Brief History, Basic Concepts, Phases of NLP, Application of chatbots, etc.

General chatbot architecture, Basic concepts in chatbots: Intents, Entities, Utterances, Variables and Slots, Fulfillment. Lexical Knowledge Networks (WordNet, Verbnet, PropBank, etc.), Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic analysis, Semantic Analysis, Word Sense Disambiguation. Information Extraction, Sentiment Analysis.

NLP using Python - Make use of any NLP libraries like NLTK, spaCy, StanfordNLP, etc. (Practice session to use an NLP Tool -Hands-on), Affective NLG.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand basic concepts of NLP.(L2)
- analyze the architecture of a chatbot. (L4)
- understand sentiment analysis. (L2)
- utilize the NLTK toolkit and python libraries. (L4)

UNIT III **8L**

Building a chatbot/Conversational AI Systems: Fundamentals of Conversational Systems (NLU, DM, and NLG). Chatbot framework & Architecture, Conversational Flow & Design, Intent Classification (ML and DL-based techniques), Dialogue Management Strategies, Natural Language Generation. UX design, APIs and SDKs, Usage of Conversational Design Tools.

Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework, Amazon Lex, RASA

Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps.

Overview of CE Testing techniques, A/B Testing, Introduction to Testing Frameworks - Botium /Mocha, Chai. Security & Compliance – Data Management, Storage, GDPR, PCI. Building a Voice/ChatBot - Hands-on

Learning Outcomes:

After completion of this unit, the student will be able to

- understand suitable ML and DL-based techniques for chatbots. (L1)
- illustrate how to construct a chatbot. (L4)
- differentiate various chatbots. (L4)
- understand the testing of a virtual assistant and its security checks. (L3)

UNIT IV **6L**

Role of ML/AI in Conversational Technologies – Brief Understanding on how Conversational Systems uses ML technologies in ASR, NLP, Advanced Dialog management, Language Translation Emotion/Sentiment Analysis, Information extraction, etc., to effectively converse.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand suitable ML techniques for Automatic Speech Recognition and NLP. (L2)

- understand the various language Conversations. (L2)
- identify the sentiment based on conversation. (L1)
- Understand how to extract useful information from the conversation. (L2)

UNIT V **6L**

Contact Centers - Introduction to Contact centers – Impact & Terminologies. Case studies & Trends, How does a Virtual Agent/Assistant fit in here?.

Overview on Conversational Analytics -Conversation Analytics: The need for it, Introduction to Conversational Metrics.

Future – Where are we headed? -Summary, Robots and Sensory Applications overview, XR Technologies in Conversational Systems, XR-Commerce. What to expect next? – Future technologies and market innovations overview.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand how virtual assistants fit their suitable applications. (L2)
- understand how analytics works for conversational metrics. (L2)
- interpret the concepts of Robots and Sensors. (L3)
- understand the importance of future extended reality technologies concerning E-commerce and business applications. (L2)

List of practical case studies

1. Build a Chatbot using AWSLex, Pandora bots.
2. Text to speech and speech to text in IBM Watson.
3. Build an AI Assistant with Wolfram Alpha and Wikipedia in Python.

https://medium.com/@salisuwy/build-an-ai-assistant-with-wolfram-alpha-andwikipedia-in-python-d9bc8ac838fe

Project 1: Case Study to build a learning chatbot. **8L**

Project 2: Case Study to build an ML Model using LSTM/any RNN and integrate with a chatbot. **10L**

Textbooks:

1. J&M: Dan Jurafsky and Jim Martin's Speech and Language Processing (3rd ed., available free online, not yet out in print)
2. Goldberg: Yoav Goldberg's Neural Network Methods for Natural Language Processing (1st ed., available free online through the NYU network)
3. Bender: Emily Bender's Linguistic Fundamentals for Natural Language Processing (1st ed., available free online through the NYU network)
4. Building Chatbots with Python Using Natural Language Processing and Machine Learning Authors: Raj, Sumi.
5. Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming

References:

Hands-on practice and online resources:

1. https://codesignal.com/
2. https://binarysearch.com/
3. https://www.codechef.com/
4. https://www.nltk.org
5. https://dialogflow.cloud.google.com/#/login
6. https://cloud.google.com/architecture/building-and-deploying-chatbot-dialogflow
7. https://aws.amazon.com/lex/
8. https://docs.aws.amazon.com/lex/latest/dg/additional-exercises.html
9. https://developers.facebook.com/docs/messenger-platform/introduction/general-best-practices/
10. https://getstream.io/blog/build-chat-messaging-app/
11. https://www.appypie.com/instant-messaging-app-builder
12. https://code.tutsplus.com/tutorials/how-to-create-a-simple-web-based-chat-application--net-5931
13. https://chatbotslife.com/the-best-books-you-need-to-read-to-understand-chat-bot-ecosystem-bdbca8e41e7f
14. https://dl.acm.org/doi/book/10.1145/3304087
15. https://web.stanford.edu/~jurafsky/slp3/24.pdf
16. https://web.stanford.edu/~jurafsky/slp3/
17. https://www.nltk.org/book/
18. https://london.ac.uk/sites/default/files/study-guides/introduction-to-natural-language-processing.pdf

Course Outcomes

After completion of this course, the student will be able to

- distinguish the concepts of artificial intelligence, natural language processing, and basic blocks of programming(L4)
- illustrate the architectures of the chatbot, virtual assistant, and using NLP tool kit. (L4)
- analyze suitable ML and DL-based techniques for chatbots and their design tools. (L4)
- identify the ML/AI techniques in different forms of conversations to extract useful information. (L4)
- illustrate the future robot technologies and scope of virtual assistants in E-commerce and markets. (L4)

19ECB343: CLOUD, MICRO SERVICES & APPLICATIONS

L	T	P	C
2	1	2	4

The course intends to introduce students to the fundamentals of developing application on Cloud, specifically public clouds. Students will attain practical experience solving problems through projects that will make use of existing public cloud tools.

Course objectives:

- Familiarize the student with the ideas behind Cloud Computing, its applicability; benefits, as well as current and future challenges
- Design applications for Cloud
- Develop applications using various services
- Deploy applications on Cloud by using cloud native services
- Know about Cloud Tools and Programming

UNIT I **8 L**

Cloud Fundamentals; Cloud Service Components, Cloud service/Deployment Models. Application of Cloud Computing. Cloud components guiding principle with respect to utilization / security/ pricing.

Learning Outcomes:

At the end of this unit, the student will be able to

- have a comprehensive understanding of Cloud Computing. (L2)
- understanding of Cloud Computing benefits and important concepts (L2)
- analyze various cloud programming models. (L3)

UNIT II **8 L**

Public Cloud Platforms Overview and their usage.

Application architectures-Monolithic & Distributed Architecture, Microservice fundamental and design approach, Spring Boot fundamentals and Design of Microservices, Cloud Native applications-12 Factors App.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the main cloud vendors and their core features and capabilities (L3)
- construct different apps leveraging micro services. (L2)
- cloud native applications built for open and secure platforms. (L3)

UNIT III **8 L**

Application integration process/Apification Process, API Fundamental, API management, API tools. Developer Portal. Applications of APIFICATION.

Devops fundamentals. tools and applications

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze API and Application Integration process. (L3)
- understanding DevSecOps practices and assets. (L2)
- analye the process of DevOps using appropriate tools(L3)

UNIT IV **8 L**

Containerization Process and application

Python – Refresher, use cases

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze applications in the business portfolio can be containerized. (L3)
- learn more about DevSecOps principles, benefits and use cases:. (L2)
- design and develop applications using Python.(L3)

UNIT V **10 L**

Instructions briefing for steps involved in Cloud Application Development/Deployment/Execution. Using containers, Project use cases covering this

(Project work / thesis: team presentation of project work / thesis – preliminary round and review)

Cloud Security and Monitoring Tools

(Project work/thesis: final submission and review)

Learning Outcomes:

At the end of this unit, the student will be able to

- compare containers to other similar technologies (L3)
- interpret security and monitoring tools in various Cloud Applications (L3)
- investigate and develop Cloud Computing projects. (L4)

Course Outcomes:

After the completion of this course, the student will be able to

- analyze and explain the concepts of cloud computing its architecture(L3)
- compare and explain different cloud deployment models and service models. (L3)
- understand and implement DevOps principles for CI/CD. (L3)
- identify and the security issues and monitoring tools in cloud computing (L3)
- analyze different cloud programming models and apply them to solve problems on the cloud.(L4)

CLOUD, MICRO SERVICES & APPLICATIONS LABORATORY

List of Practical Experiments:

1. Chose a real life example of a Business application that you have used and apply these technologies and concepts to solution it.
2. Cloud Architecture Design
3. Microservice Architecture Design
4. API development use case and deployment
5. Microservice development and deployment
6. Devops Tools usages for Automation in development/Testing/Deployment
7. AWS features use cases -ex, Lambda Functions
8. Azure features use cases
9. GCP Features Use cases
10. Creating an API and API Documentation
11. Cloud scaling

Text Book(s)

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing Principles and Paradigms, Wiley Publishers, 2011.

References

1. Barrie Sosinsky, Cloud Computing Bible, Wiley Publishers, 2010
2. Michael Miller, Cloud Computing: Web-based Applications that change the way you work and collaborate online, Pearson Education, 2008
3. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly, 2010

19ECB345: MACHINE LEARNING

L	T	P	C
2	1	2	4

Machine learning is about designing programs that can learn without being explicitly programmed. It is a branch of Artificial Intelligence in which we learn concepts/patterns/hypotheses from Data by using heuristic based algorithms. Accordingly, this field is about study and implementation of two main category of algorithms: Supervised and Unsupervised. Supervised learning algorithms make use of data with known classification, aka labelled examples whereas Unsupervised learning algorithms use data with unknown classification, aka unlabelled examples. This field has become so popular that one can find machine leaning applications in virtually all domains ranging from identifying emails as spam or legitimate to automated vehicle guided system to game playing to credit card fraud detection. As this form is unlikely to become exact science, a learning method/algorithm needs to be evaluated and estimated for its performance on unseen data or the population

Course objectives:

- Provide introduction to basic concepts of machine learning and classification techniques.
- Introduce the concepts of statistical decision techniques
- Explore the regression techniques and association mining rules
- Understand the different clustering algorithms
- Exposure mathematical models or techniques

UNIT I Introduction to Machine Learning 6T 3P

Introduction to Machine Learning (ML), Relationship between ML and human learning; A quick survey of major models of how machines learn; Example applications of ML, Classification: Supervised Learning; The problem of classification; Feature engineering; Training and testing classifier models; Cross-validation; Model evaluation (precision, recall, F1-mesure, accuracy, area under curve), Expectation-Maximization (EM) algorithm for unsupervised learning.

Learning Outcomes:

After completion of this unit, the student will be able to:

- identify different machine learning approaches and applications (L1)
- demonstrate basic machine learning approach using real world data (L2)
- use Feature Engineering techniques for feature selection and feature extraction of data (L3)

UNIT II Statistical decision theory and classification 8T 5P

Statistical decision theory including discriminant functions and decision surfaces; Naive Bayes classification; Bayesian networks; Decision Tree and Random Forests; k-Nearest neighbour classification; Support Vector Machines, Artificial neural networks including backpropagation; Applications of classifications; Ensembles of classifiers including bagging and boosting.

Learning Outcomes:

After completion of this unit, the student will be able to:

- demonstrate various supervised learning approaches(L2)
- describe classification techniques for real-time data. (L2)

- apply classification techniques to make good predictions (L3)
- compare the performance of ensemble learners to weak learners (L4)

UNIT III Regression 6T 4P

Regression: Multi-variable regression; Model evaluation; Least squares regression; Regularization; LASSO; Applications of regression.

Association rule mining algorithms including apriori.

Learning Outcomes:

After completion of this unit, the student will be able to:

- apply regression to make good predictions (L3)
- identify the Association rule mining algorithms.(L1)
- analyze a Model using all regression techniques.(L4)

UNIT IV Clustering 6T 4P

Clustering: average linkage; Ward's algorithm; Minimum spanning tree clustering; K-nearest neighbors clustering; BIRCH; CURE; DBSCAN

Anomaly and outlier detection methods.

Learning Outcomes:

After completion of this unit, the student will be able to:

- illustrate various clustering techniques (L2)
- construct Gaussian Mixture Models to implement anomaly detection (L3)
- analyze suitability of different clustering techniques for real-time data (L4)

UNIT V Hidden Markov Model(HMM) 6T 4P

Hidden Markov Models (HMM) with forward-backward and Viterbi algorithms; Sequence classification using HMM; Conditional random fields; Applications of sequence classification such as part-of-speech tagging.

Learning Outcomes:

After completion of this unit, the student will be able to:

- use Markov chain model to identify the probabilities of sequences of random variables, states(L3)
- illustrate the relation between a sequence of observations and a sequence of hidden classes or hidden states that explain the observations(L2)
- analyze the Viterbi algorithm which is commonly used for decoding(L4)

Reference Books:

1. R.O. Duda, P.E. Hart, D.G. Stork, **Pattern Classification**, 2/e, Wiley, 2001.
2. C. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2007.
3. E. Alpaydin, **Introduction to Machine Learning**, 3/e, Prentice-Hall, 2014.
4. A. Rostamizadeh, A. Talwalkar, M. Mohri, **Foundations of Machine Learning**, MIT Press.
5. A. Webb, **Statistical Pattern Recognition**, 3/e, Wiley, 2011.

Course Outcomes:

- describe different machine learning categories (L2)
- apply supervised learning approaches on real-time problems (L3)
- utilize unsupervised learning approaches for applications such as anomaly detection(L3)
- analyse ensemble models for performance improvement (L4)
- estimate significant feature subset to handle high dimensionality issue (L5)
- construct Hidden Markov Model for specific application (L6)

MACHINE LEARNING LABORATORY

List of Experiments:

Lab Sessions:
1.Introduction to WEKA and R
2.Classification of some public domain datasets in UCI ML repository

Mini projects in the Lab:
1.Implementation of one clustering algorithm
2.Implementation of one association rule mining algorithm
3.Implementation of one anomaly detection algorithms
4.Implementation of EM algorithm for some specific problem

19ECB391: MINI PROJECT

L	T	P	C
0	0	2	1

Contents

1. Mini Project is a short project intended to train students to identify an industry application problem related to software design process, various tools used in the industry, application/ software development.
2. Study of literature related to any of the above and works for a solution and submit a report.
3. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
4. The mini project can be individual or maximum of four persons.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Semester VI

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB332	Computer Networks	PC	3	0	4	5
2	19ECB334	Information Security	PC	3	0	2	4
3	19ECB336	Artificial Intelligence	PC	3	0	2	4
4	19EID302	Financial & Cost Accounting	MS	2	0	0	2
5	19EHS331	Business Communication & Value Science IV	HS	2	0	2	3
6	19ECB34X	Elective II	PE	2	0	2	3
7	19EHS304	Universal Human Values: Understanding Harmony	HS	2	1	0	3
Total				**24**			
Industrial Project (6-8weeks)							

19ECB332: COMPUTER NETWORKS

L	T	P	C
3	0	4	5

The course is designed to impart a basic understanding of the working of computer networks, with the Internet as the case in point. After giving an introduction about the concepts in physical layer this course mainly deals with the different principles and protocols used in Datalink layer to Application Layer. Introduction to socket programming and wireless networks are also introduced.

Course objectives:

- Describe the general principals of data communications. (L1)
- Compare the layered approach used in different computer networks. (L2)
- Understand the signalling systems to transfer the data across communicating systems. (L2)
- Differentiate how the packets are moved over the subnet using different routing protocols. (L2)
- Plan small logical sub-address blocks within a given large address block. (L5)
- Choose correct protocol depending on the type of the data. (L3)
- Understand how application are deployed. (L2)
- Configure both wired and wireless networks. (L4)

UNIT I **8L**

Introduction: Computer networks and distributed systems, Classifications of computer networks, Preliminaries of layered network structures.

Data communication Components: Representation of data and its flow, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media.

LAN: Wired LAN, Wireless LAN, Virtual LAN.

Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the principles of data communications. (L1)
- compare the layered approach used in different computer networks. (L2)
- differentiate the advantages and disadvantages of Wired LAN, Wireless LAN and Virtual LAN

UNIT II **8L**

Data Link Layer and Medium Access Sub Layer: Fundamentals of Error Detection and Error Correction, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols - Pure ALOHA, Slotted ALOHA, CSMA/CD, CSMA/CA.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the signalling systems to transfer the data across communicating systems. (L2)
- understand the protocol for delivery of the packets without any error in different network conditions. (L2)

UNIT III **10L**

Network Layer: Network Layer Design Issues, Forwarding and Unicast Routing protocols (Routing algorithms: The optimality principle, shortest path algorithm, flooding, distance vector routing, link state routing, hierarchical routing). Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery.

Learning Outcomes:

At the end of this unit, the student will be able to

- contrast how the packets are moved over the subnet using different routing protocols. (L2)
- plan small logical sub-address blocks within a given large address block. (L5)
- understand the mapping between addresses using Network layer protocols. (L2)

UNIT IV **8L**

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service (QoS), QoS improving techniques - Leaky Bucket and Token Bucket algorithms.

Learning Outcomes:

At the end of this unit, the student will be able to

- choose correct protocol depending on the type of the data. (L3)
- choose a protocol for smooth delivery of the packets irrespective of the hosts and network conditions. (L3)
- understand what is meant by quality of service (L2)

UNIT V **8L**

Application Layer: DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls.

Network Security: Electronic mail, directory services and network management, Basic concepts of Cryptography.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand how application are deployed. (L2)
- understands the basic concepts of cryptography. (L2)
- develop simple network applications using socket programming(L6)

COMPUTER NETWORKS LABORATORY

1. Analysing the frame using Wireshark tool.
2. Network System Administration: Understanding hosts, switches and routers. Simple LAN design experiments using Cisco's Packet Tracer tool.
3. Simulation of ARP, RARP and routing using Cisco's Packet Tracer tool.
4. Socket Programming using C/C++/Java/Python

Text Books:

1. A. Tannenbaum, Computer Networks,. 5th edition , Pearson
2. William Stalling, Data and Computer Communication, 10th edn. , Pearson

References:

1. Kaufman, R. Perlman and M. Speciner, Network Security.
2. W. Richard Stevens, UNIX Network Programming, Vol. 1, 2 & 3.
3. https://www.netacad.com/courses/packet-tracer

19ECB334: INFORMATION SECURITY

L	T	P	C
3	0	2	4

The ability to secure information within a modern enterprise—large or small—is a growing challenge. Threats to information security are global, persistent, and increasingly sophisticated. Effective information security at the enterprise level requires participation, planning, and practice. This course is designed to teach mid-level security practitioners how to engage all functional levels within the enterprise to deliver information system security

Course objectives:

- Familiarize the students with basic computer security parameters and making them understand the concept of different access control models.
- Comprehensive understanding of security policies requirements and standards.
- The various design technologies to implement appropriate security principles.
- Identify some of the factors driving the need for network security and cover the fundamentals of forensics.
- Cover in details of various state-of-art database security and operating system methods and techniques.

UNIT I **10 L**

Overview of Security Parameters: Confidentiality, integrity and availability; Security violation and threats; Security policy and procedure; Assumptions and Trust; Security Assurance, Implementation and Operational Issues; Security Life Cycle.

Access Control Models: Discretionary, mandatory, roll-based and task-based models, unified models, access control algebra, temporal and spatio-temporal models.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the basic security parameters. (L2)
- determine the implementation and operational security issues. (L3)
- categorize between different types of access control models. (L2)
- analyse the fundamental issue of access control in information security. (L4)

UNIT II **8 L**

Security Policies: Confidentiality policies, integrity policies, hybrid policies, non-interference and policy composition, international standards.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify the security policies. (L1)

- analyze policy compositions. (L4)
- understanding of international standard security policies. (L2)

UNIT III **8 L**

Systems Design: Design principles, representing identity, control of access and information flow, confinement problem. Assurance: Building systems with assurance, formal methods, evaluating systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand design principles. (L2)
- articulate confinement problem with assurance. (L3)
- evaluate design method formals. (L5)

UNIT IV **8 L**

Logic-based System: Malicious logic, vulnerability analysis, auditing, intrusion detection. Applications: Network security, operating system security, user security, program security. Special Topics: Data privacy, introduction to digital forensics, enterprise security specification.

Learning Outcomes:

At the end of this unit, the student will be able to

- define the terms vulnerability, threat and attack. (L1)
- identify physical points of vulnerability in simple networks. (L1)
- explain the role of digital forensics and the relationship of digital forensics to traditional forensic science, traditional science and the appropriate use of scientific methods. (L2)
- outline a range of situations where digital forensics may be applicable. (L2)

UNIT V **10 L**

Operating Systems Security: Security Architecture, Analysis of Security in Linux/Windows.
Database Security: Security Architecture, Enterprise security, Database auditing.

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate understanding of security architecture in modern computer systems in a typical enterprise. (L3)
- formulate a working definition of database security and administration. (L5)
- identify contemporary practices of operating system security. (L1)
- demonstrate the knowledge and skills for administration of user, profiles, password policies, privileges and roles. (L3)
- manage database security on application level. (L4)

Course Outcomes:

After the completion of this course, the student will be able to

- understand the basic security parameters and analyse the fundamental issue of access control in information security. (L4)
- identify the security policies and policy compositions. (L1)
- understanding of design principles and articulate confinement problem with assurance. (L3)
- explain the role of digital forensics and the relationship of digital forensics to traditional forensic science, traditional science and the appropriate use of scientific methods. (L2)
- demonstrate the knowledge and skills for administration of user, profiles, password policies, privileges and roles and manage database security on application level. (L3)

INFORMATION SECURITY LABORATORY

List of practical experiments:

1. Analysis of security in Unix/Linux.
2. Administration of users, password policies, privileges, and roles.

Text Book(s):

1. M. Bishop, Computer Security: Art and Science, Pearson Education.
2. Ross Anderson, Security Engineering.
3. M. Stamp, Information Security: Principles and Practice.

References:

1. C.P. Pfleeger, S.L. Pfleeger, J. Margulies, Security in Computing.
2. David Wheeler, Secure Programming HOWTO.
3. Michael Zalewski, Browser Security Handbook.
4. M. Gertz, S. Jajodia, Handbook of Database Security.

19ECB336: ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	2	4

This course introduces students what exactly artificial intelligence means, how to analyze problems before solving, working of intelligent agents, various search techniques, general-purpose search algorithms, intelligent environments in which agents compete with one another, the basic knowledge representation, problem solving with uncertain knowledge, and knowledge of expert systems.

Course objectives:

- To understand the fundamentals of artificial intelligence and the concept of intelligent agents.
- To gain an insight into the problem-solving process through uninformed and informed searches and their various techniques.
- To describe real-world problems through constraint satisfaction and understand the working of intelligent agents in a competitive environment.
- To represent knowledge using logic and rules.
- To explore uncertainty reasoning through probability, problem solving by decomposition and understand expert systems.

UNIT I **8 L**

Introduction, Overview of Artificial intelligence: What is Artificial Intelligence? The AI Problems, what is an AI technique, Tic-Tac-Toe problem;

Problems, Problem Spaces and Search: Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Issues in the Design of Search Programs;

Intelligent Agents: Agents and Environments, The nature of Environments, The Structure of Agents: Goal-based agents, Utility-based agents, learning agents.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain what is artificial intelligence (L2)
- analyze problems before solving them (L4)
- compare the working of intelligent agents (L4)

UNIT II **10 L**

Search Techniques: Solving Problems by Searching: Problem-solving agents, Searching for Solutions; Uniformed Search Strategies: Breadth-first Search, Depth-first Search, Depth-limited Search, Bidirectional Search, Comparing Uniformed Search Strategies;

Informed Search and Exploration: Informed (Heuristic) Search Strategies, Greedy Best-first search, A* Search; Local Search Algorithms and Optimization Problems: Hill climbing Search, Simulated Annealing Search, Local Beam Search.

Learning Outcomes:

At the end of this unit, the student will be able to

- illustrate various search mechanisms (L2)
- classify search techniques into uninformed and informed (L2)
- experiment with uninformed and informed search methods (L3)

UNIT III **8 L**

Constraint Satisfaction Problems: Constraint Satisfaction Problems, Local Search for Constraint Satisfaction Problems;

Adversarial Search: Games, Optimal Decisions in Games, Optimal Strategies, The minimax algorithm, Optimal Decisions in Multiplayer Games, Alpha-Beta Pruning.

Learning Outcomes:

At the end of this unit, the student will be able to

- define what are constraint satisfaction problems (L1)
- illustrate general-purpose heuristics (L2)
- model the working of intelligent agents in a competitive environment (L3)

UNIT IV **8 L**

Knowledge and Reasoning: Knowledge Representation Issues: Representations and Mappings, Approaches to Knowledge Representation, Issues in Knowledge Representation;

Using Predicate Logic: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution, Natural Deduction;

Representing Knowledge using Rules: Procedural versus Declarative Knowledge, Logic Programming, Forward versus Backward Reasoning, Matching, Control Knowledge.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain what is knowledge representation (L2)
- demonstrate representation of knowledge using predicate logic (L2)
- make use of rules in representing knowledge (L3)

UNIT V **8 L**

Probabilistic Reasoning: Statistical Reasoning: Probability and Bayes' Theorem, Bayesian Networks, Dempster-Shafer Theory;

Planning: Overview, An Example Domain: The Blocks World, Components of a Planning System, Goal Stack Planning, Hierarchical Planning;

Expert Systems: Representing and using Domain knowledge, Expert System Shells, Knowledge Acquisition.

Learning Outcomes:

At the end of this unit, the student will be able to

- outline what is uncertainty in knowledge representation (L2)
- illustrate problem solving through planning techniques (L2)
- examine the working of expert systems (L4)

Course Outcomes:

After completion of this course, the student will be able to

- summarize what Artificial Intelligence is and the role of Intelligent Agents (L2)
- develop the uninformed and informed search techniques and tracing the execution of various search algorithms (L3)
- illustrate constraint satisfaction problems and game environments (L2)
- build a knowledge base and answer queries (L3)
- explain uncertainty reasoning, planning techniques and expert systems (L2)

Home Assignments:

Assignments should include problems related to the topics covered in lectures, like heuristics, optimal search, and graph heuristics. Constraint satisfaction problems, k-nearest neighbours, decision trees, etc., can be included in home assignments.

ARTIFICIAL INTELLIGENCE LABORATORY

List of Practical Experiments:

AI TOOLS:

1. Perform Data Labelling for various images using object recognition (work with supervisely)
2. Teachable Machine
3. Building a Chatbot using Pandora bots
4. Configure an existing Neural Network by manipulating various parameters involved
5. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python

PROLOG:

1. Design a simple database in Prolog using constants and variables and execute queries.
2. Find out whether an element is a member of list using recursion.
3. Find out the sum of numbers from 1 to N using 'cut' predicate.
4. Demonstrate the usage of 'cut-fail' combination.
5. Demonstrate Input / Output in Prolog:
   (i) Reading and writing Terms
   (ii) Reading and writing Characters
   (iii) Reading English sentences

Text Book(s)

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edn.
2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, 3rd Edn.
3. William F. Clocksin, Christopher S. Mellish, Programming in Prolog, 5th Edition, Springer.

Reference Book

1. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI.

References

1. AurélienGéron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media,2017
2. Build an AI Assistant with Wolfram Alpha and Wikipedia in Python. https://medium.com/@salisuwy/build-an-ai-assistant-with-wolfram-alpha-and-wikipedia-in-python-d9bc8ac838fe
3. Joseph Howse, Prateek Joshi, Michael Beyeler - Opencv_ Computer Vision Projects with Python-Packt Publishing (2016).
4. Curated Datasets on Kaggle: https://www.kaggle.com/datasets.

19EID302: FINANCIAL & COST ACCOUNTING

L	T	P	C
2	0	0	2

This course focuses on the concepts of financial and cost concepts to managerial decisions. The concepts of financial and cost analysis have considerable relevance for management and productivity improvement. It is essential to manage the financial aspects of a business effectively if it is to remain viable. Further, if productivity improvement is to be successful, then financial resources need to be managed effectively. It resembles that the financial consequences of any productivity improvement option must have been analysed and considered.

Course objectives:

- To create an awareness about the importance and usefulness of the accounting concepts and their managerial implications.
- To develop an understanding of the accounting concepts and prepare financial statements.
- To analyze and interpret financial statements to take managerial decisions.
- To create an awareness about cost accounting, different types of costing and cost management.

UNIT I **5L**

Accounting Concept: Introduction – Concepts and Conventions – Bookkeeping and Record Maintenance – Fundamental Principles and Double Entry system.
Accounting Process: – Journal – Ledger – Cash Book and Subsidiary Books.

Learning Outcomes:

At the end of this unit, the student will be able to

- basics, and Concepts and Conventions of accounting (L1, L2)
- prepare journals, ledgers, and subsidiary books of accounting (L3)

UNIT II **5L**

Preparation of Financial Statements: Trial Balance – Preparation of Income and Position Statement. Final Accounts with Adjustments: Closing Stock – Prepaid Expenses – Outstanding Expenses – Accrued Incomes – Interest on Capital – Bad Debts – Depreciation (Methods of Depreciation need to discuss).

Learning Outcomes:

At the end of this unit, the student will be able to

- prepare income and position statement (L3)
- use additional information (adjustment) to prepare financial statements (L4)

UNIT III **7L**

Introduction to Costing: Classification of costs – Cost Behaviour.
Cost Sheet: Preparation of cost sheet – Special work orders. Introduction to labour cost and its types – overheads – classification – apportionment – absorption.

Learning Outcomes:

At the end of this unit, the student will be able to

- prepare cost sheets for special work orders (L3)
- know the overhead apportionment process (L4)

UNIT IV **5L**

Cost Accounting Systems: Marginal Costing: P/V Ratio – BEP – Decision involving alternative choices – Limiting factor or Key Factor. Activity-Based Costing (ABC) – Allocation of overheads under ABC.
Budgeting and Budgetary Control: Types of budgets – Preparation of Production Budgets – Approaches to Budgeting – Zero-based Budgeting.
Class Discussion: Application of cost concepts in the Service Sector.

Learning Outcomes:

At the end of this unit, the student will be able to

- use the marginal costing techniques in decision making (L5)
- prepare and anlayse the different types of budgets (L4)

UNIT V **7L**

Financial Statement Analysis: Analyzing and Interpreting Financial Statements by using Cash Flow and Fund Flow Techniques. Preparation of Cash Flow and Funds Flow Statements.
Analysis of Annual Reports: IAS and IFRS **–** Audit Reports and Statutory Requirements – Directors Report – Notes to Accounts – Pitfalls.
Class Discussion: Corporate Accounting Fraud- A Case Study of Satyam

Learning Outcomes:

At the end of this unit, the student will be able to

- analyse the financial statements by using Cash and Funds flow statements (L4)
- understand how to analyse the annual report (L4)

Course Outcomes:

After the completion of this course, the student will be able to

- learn the fundamental concepts and conventions of accounting to prepare financial statements. (L1, L3 & L4)
- analyse the financial statements by using Cash and Funds flow statements (L4)
- use the marginal costing techniques in decision making (L5)
- create an awareness about the importance and usefulness of the accounting concepts and their managerial implications (L1, L3, L4 & L5).

Home Assignment:

A case study materials book will be given to the students. Students are required to meet in groups before coming to class and prepare the case for the day. The instructor may ask the student groups to present their analysis and findings to the class.

Further, there will be periodic homework assignments relating to the course concepts or mini-cases. Specific instructions will be given separately. Few topics are mentioned below as examples. The instructor can add or change any topic as per requirement.

3. Topic: Corporate Accounting Fraud: A Case Study of Satyam
4. Topic: Application of cost concepts in the Service Sector

Text Books:

1. Robert N Anthony, David Hawkins, Kenneth Marchant, Accounting: Texts and Cases, McGraw-Hill
2. Case Study Materials: To be distributed for class discussion.

19EHS331: BUSINESS COMMUNICATION &VALUE SCIENCE IV

L	T	P	C
2	0	2	3

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 5 Hrs./Week	Semester Examination: 50	3
Practical: 2 Hrs. / Week	Continuous Assessment: Yes	
Lab: 1 Hr / Week	Term Work: marks	

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of English (verbal and written) Completion of all units from Semesters 1, 2, 3, 4 and 5

Course objectives:

1	Recognize the importance of diversity in workplace
2	Recognize the best practices of communicative writing
3	Understand the importance of emotional intelligence in personal and professional lives
4	Apply emotional intelligence in real life scenarios
5	Use the best practices of public speaking in real life scenarios
6	Understand the importance of corporate social responsibility (CSR)
7	Understand the importance of corporate etiquettes
8	Practice corporate etiquettes in real life scenarios
9	Recognize the best practices to share and receive feedback
10	Use the basic guidelines required to manage conflicts
11	Understand how stress impacts life and work
12	Use the best practices to manage stress

13	Practice the best time management practices	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
	Understand the importance of diversity in workplace	[U]
	Apply emotional intelligence in real life scenarios	[AP]
	Recognize the best practices of communicative writing	[AP]
	Understand the importance of corporate social responsibility (CSR)	[C]
	Recognize the importance of time management	[U]
	Apply knowledge of multiple intelligences and learning styles in interpersonal interactions	[AP]
	Recognize the impact of stress in life and work	[E]
	Understand how stress impacts life and work	[U]
	Identify the best practices to manage stress	[AP]
	Recognize the attributes needed to function and grow in a corporate environment	[U]
	Recognize the best practices to share and receive feedback	[AP]
	Identify the best time management practices	[E]

Course Contents:

Objectives for Semester 6

- Understand the importance of diversity in workplace
- Identify the key aspects of communicative writing
- Apply communicative writing in real life scenarios
- Use charts and graphs in communicative writing
- Understand what is emotional intelligence
- Recognize the importance of emotional intelligence in personal and professional lives
- Understand why you would need public speaking at your workplace
- Identify the best practices of public speaking
- Apply public speaking in real life scenarios
- Recognize the importance of corporate social responsibility (CSR)
- Recognize the importance of corporate social responsibility (CSR)
- Recognize the attributes needed to function and grow in a corporate environment
- Recognize the best practices to share and receive feedback
- Apply emotional intelligence in real life scenarios
- Apply knowledge of multiple intelligences and learning styles in interpersonal interactions
- Recognize the impact of conflicts
- List the basic guidelines required to manage conflicts
- Recognize the key features of corporate etiquette
- Recognize the business idioms and corporate terms
- Apply the business idioms and corporate terms
- Recognize the impact of stress in life and work

• Identify the best practices to manage stress • Recognize the importance of time management • Identify the best time management practices	
Total Hours:	45 hours 40 hours of must know + 5 hours of nice to know learning
Text Books:	
	There are no prescribed texts for Semester 6 – there will be handouts and reference links shared.
Reference Books:	
1	Emotional Intelligence: Why it Can Matter More Than IQ by Daniel Goleman
2	Putting Emotional Intelligence To Work by Ryback David
3	How to Develop Self Confidence and Improve Public Speaking - Time - Tested Methods of Persuasion by Dale Carnegie
4	TED Talks: The official TED guide to public speaking: Tips and tricks for giving unforgettable speeches and presentations
Web References:	
1	https://www.tata.com/about-us/tata-group-our-heritage
2	https://economictimes.indiatimes.com/tata-success-story-is-based-on-humanity-philanthropy-and-ethics/articleshow/41766592.cms
Online Resources:	
1	https://youtu.be/reu8rzD6ZAE
2	https://youtu.be/Wx9v_J34Fyo
3	https://youtu.be/F2hc2FLOdhI
4	https://youtu.be/wHGqp8lz36c
5	https://youtu.be/hxS5He3KVEM
6	https://youtu.be/nMPqsjuXDmE

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C1.6.1			5

C1.6.2			4
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand			
Apply			
Analyze			

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	NA – Recapitulation activity	Recall information	**Auld Lang Syne** This will be a group activity in which lecturer will give some key words (from what they taught in the previous semesters). Each group will identify topics related to the key words and take 2 mins to share a summary of what they learnt in that topic. They can refer to their Satori books and finally note down these key learnings too.	Activity	45 mins
1	Understand the importance of diversity in workplace	2	Introduce the concept of Diversity in corporate environments through an activity.	Activity	45 mins
1	Understand the importance of diversity in workplace	2	Discussion, role plays and sharing reference materials.	Discussion and Practical	60 mins
1	Identify the key aspects of communicative writing	2	**Communicative Writing** • Principles of Communicative Writing • Formal and Business letters	Lecture and practice	90 mins (30 mins lecture + 60 mins practice)
1	Apply communicative writing in real life scenarios	3	**Writing proposals** This will be taught through a group activity in which students will be asked to create a business proposal to get funding to begin a start-up of their choice. After they share their	Lecture and activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			presentations, lecturer will share the best practices and templates for writing proposals (will be provided to the lecturer as part of the Faculty guide) and ask students to review their proposal and update it. Students should save this proposal for reference later in the sem. Students will have to continue in these groups for the rest of this sem.		
1	Use charts and graphs in communicative writing	3	**How to tell a story with charts and graphs** Session will begin with a couple of demo videos. This will be followed by an activity on how to visually represent information to tell a complete story. Students will be required to use the proposal for the start-up that they created in the previous class for this.	Practical	60 mins
1	Understand what is emotional intelligence Recognize the importance of emotional intelligence in personal and professional lives	2	**Emotional Intelligence** Begin with a short video/movie clip showing manifestations of EI. Introduce the concept of EI and give them the experience through a game/activity. Discuss the findings that students with higher EQ write better exam papers. **Ref reading**: 10 Ways to Build EI by Daniel Goleman Ask students to note down the names of at least two movies in their Satori slam book, in which the characters display EI.	Lecture and activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Understand why you would need public speaking at your workplace	2	**Why do we need public speaking?** Any two of the YouTube /IncTalks videos: a. Swami Vivekananda's Chicago speech b. Steve Jobs' first iPhone launch c. Martin Luther King Jr (I have a dream…) d. J K Rowling commencement speech address 2008 e. APJ Abdul Kalam f. Any regional speakers Professors to ask what is common in these videos and lead them to the concept of public speaking (directions will be provided in the Facilitator's Guide). Session for students to re-visit the group discussion and value proposition sessions that they participated in during the previous semesters. (This will be integrated in the semester 6 content)	Lecture and discussion	60 mins
1	Identify the best practices of public speaking		**Public speaking – best practices** Ask each group (formed earlier) to research and come up with a list of best practices along with examples (in the class). After each group presents their list of best practices, students will discuss and create a consolidated list of best practices by considering all common or overlapping ones and map it against the guidelines provided by the TCS team.	Activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Additional: Possible guest lecture or webinar (Dr Giri)		
1	Apply public speaking in real life scenarios	3	**Get, Set, Go – sell your start-up ideas** Each group to pitch their start-up idea to a panel consisting of external professors. They will use the presentation they created earlier and the best practices of public speaking to tell their story leveraging the storytelling and doodling methods they learnt in the previous semester (Design Thinking). Their story should at least include: • Name of their start-up • Who is the target audience/end user? • What problem will their start-up solve? • How do they plan to run start up? • How much money/budget would they need to begin their work? Professors to share the results of this formative assessment with the TCS Team so that we can use it for reference in GD post sem.	Formative assessment	120 mins
1	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
2	Recognize the importance of corporate social responsibility (CSR)	1	**Corporate Social Responsibility (CSR)** Ubuntu story – A story to introduce the concept of social responsibility. The story will be played through an audio embedded	Lecture	45 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			in the PPT (similar to an audiobook).		
2	Recognize some of the stalwarts in CSR	1	**Hear CSR stories** • Meeting of JNT and Swami Vivekananda. • Societal connect of JNT. Stalwarts in CSR (Led by Tatas) • More Tata Group CSR stories --- from Titan and Tata Chemicals Initially, Professors will share any two of the above CSR stories. Thereafter, they will discuss the stories in the class and ask the students to share their thoughts. Lecturer to ask students why they need to conduct CSR activities? (Answers will be given in handouts provided by the TATA Team) Why do corporates need to engage in CSR? Is it for compliance only? The answers to these questions (given in the content) will refer back to the topics on TCS values, life skills and empathy taught in the earlier semesters. Lecturer to explain to the students how CSR connects to their values and how CSR activities can add value to their resumes.	Lecture	60 mins
2	Recognize the importance of corporate social responsibility (CSR)	1	**Tell a CSR story** Activity - Groups will research in class, prepare and present CSR activity of Tata Steel, Microsoft, Google, TCS, Starbucks, Titan, Tata Chemicals and TOMS Shoes.	Practice activity	90 mins
2	Recognize the attributes needed to function and	1	**Attributes required for work and life** • Qualities of a good team	Lecture and discussion	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	grow in a corporate environment		member: a) Resilience b) Flexibility c) Strategic thinking and planning d) Decision making e) Resolving conflicts Professors to first show examples and non-examples and then the participants to identify the traits that set them apart.		
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
3	Recognize the attributes needed to function and grow in a corporate environment	1	Activity – **Who am I?** (Image Management. Building a perfect image) This is an individual activity in which each participant needs to reflect upon the following questions (in the order given below) and jot down the answers. They will be given a handout with the questions printed on it for this activity. 1. What do I wish to be seen as? (aspirational state) 2. How do I see myself now? (present state) 3. How others see me? (perceptions) 4. What is the gap between how others see me and how I see myself? 5. How do I fill the gap? Why is it important to fill the gap (connect to importance of personal branding to stay	Activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			relevant). Professor to share examples of personal branding in the corporate world, as mentioned in the content.		
3	Recognize the best practices to share and receive feedback	1	**Examination Result Activity - Locus of control** (referring back to Emotional intelligence) One person from each group (to be decided through drawing lots) will be asked to step aside to act as teachers. The rest of the group members will participate as students. Each group will be given a scenario in which they will get mock grades in an examination. They will be asked to react to their result. Their reactions will be noted. • Examination Result Activity-Phase II –Role play on feedback. Now the teachers will be asked to have a discussion with each one to two people from each group sharing their feedback on their reactions. After the activity, tips to receive and give feedback will be shared. Handouts will be shared with lecturers.	Activity	90 mins
3	Apply emotional intelligence in real life scenarios	3	**Applying emotional intelligence** Activity for applying Emotional Intelligence using scenarios within each start-up group. There will be separate scenarios for each group. Professors will judge the	Lab Activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			groups based on guidelines provided by the TCS team.		
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
4	Apply knowledge of multiple intelligences and learning styles in interpersonal interactions	3	**Sensitivity to diversity - Quiz** A scenario-based quiz on (handouts to refresh Sem-1 content on multiple intelligences and learning styles followed by scenario-based quiz) – awareness of multiple intelligences and learning styles in communication. The questions will be based on scenarios that the students might face later in their work environment.	Formative assessment	60 mins
4	Recognize the impact of conflicts		**Understanding conflicts** This will be a group activity. Each group will be given a scenario of typical conflicts that occurs in a corporate office. In each group roles will be assigned to the group members who would be expected to play it. Each group will enact the situation while others watch and note down their observations on: 1. What is the conflict? 2. What has caused the conflict? 3. What is the negative impact of the conflict? 4. What can be a positive impact of the conflict? Each group will be requested to draw up a list of tips to	Activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			manage conflicts at work and share in the next class and post on their Fb/Insta page. They can compare it with handout provided to lecturers. Student needs to reflect upon lessons in empathy and active listening (taught in the previous semesters) while managing conflicts. Each person will be requested to capture at least one Satori moment from these enactments of real-life scenarios.		
4	List the basic guidelines required to manage conflicts	1	**Tips to manage conflicts** Each group will share their list of guidelines to manage conflicts, post which the lecturer can share the standard list provided (as a hand-out) and discuss the main points in the class. After that the lecturer will ask them to reflect on what are the changes they need to bring about in their behaviour, based on Belbin's Team Player roles (Sem 2 Unit 3).	Lecture	60 mins
4	Recognize the key features of corporate etiquette	1	**Corporate etiquette** Mock interview rounds for each group with a prospective employer followed by discussions on corporate etiquette (leverage Interview Ready app)	Activity	60 mins
4	Recognize the business idioms and corporate terms Apply the business idioms and corporate terms	1 3	**Business idioms and Corporate Terms** This will begin with a quiz in which in the first four rounds each group needs to identify the business idioms and corporate terms from given excerpts. In the next four rounds they will be asked to	Lab activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			supply the correct idiom or term in a given business scenario. After the quiz, the lecturer would share handouts of common business idioms and guide them to download the TCS BizVocab on their smartphones.		
4	Recognize the impact of stress in life and work	1	**Managing Stress** Participants will first watch a short YouTube video: Managing Stress - Brainsmart – BBC (2:24 mins) Then the lecturer will discuss stress and its impact through the following questions: 1. Have you ever felt stressed? 2. What are the situations that make you feel stressed? 3. Does the stress help you in overcoming the situation? 4. Do you know how stress affects your health? After this they will watch a video on how stress impacts health: YouTube: The Long-term Effects of Stress (5 mins) Finally, each group will be asked to create a poster with stress management tips to be presented in the next class and uploaded on their Fb/Insta pages.	Lecture	60 mins
5	Identify the best practices to manage stress	1	**Tips to manage stress** Each group will present their posters and the class will come up with a list of stress management tips to be put up on the Fb/Insta page. They should also note this in their journals so that they can	Discussion Activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			refer to it whenever they feel stressed.		
	Recognize the importance of time management	1	**Time management** Session begins with an introductory activity that establishes the fact that we often manage time poorly and as a result experience stress. After that participants will watch the YouTube video: Importance of Time Management For Better Life Style (3:33 mins) Now the lecturer will conduct an open house discussion, where the participants will share their challenges to manage time. Now the lecturer will ask the participants to evaluate their ability to handle their daily task within 24 hrs on a scale of 10. This is a confidential rating which participants needs to note down in their satori book with date and time for future reference. (this activity will be repeated at a later stage)	Lecture	45 mins
	Identify the best time management practices	1	**Managing your time better** The class will start with the YouTube video: A valuable lesson for a happy life (2:33 mins) After viewing this, the facilitator will ask the participants to identify the rocks, pebbles and sands in their life. This will be followed by the **Time Squared Activity**: Each participant gets 3 pages with 24 squares representing the hours in a day. Participants need to fill out: The **first page** with the everyday activities in their day	Activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			(example, brushing teeth, bathing, meals, travelling, etc) The **second page** with the non-productive work that they do every day (social media, mobile-games, etc) On the third page they can add everything from the first two pages to find out the empty spaces. That is their productive time when they can study. This gives them a view of what they can adjust in order to increase their study time. Reference video: Study Skills – Managing your time (4:29 mins) Participants to repeat the self-evaluation exercise. In this instant, the participants will evaluate their ability to plan their daily task on a scale of 1 to 10 with date and time. Lecturer to encourage participants to evaluate their time management skills on a regular basis.		
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
		1	**Create memories** Recap activity on the entire BCVS Course.		30 mins
				Total	**30 hours**
			Project Each group to create a POC (Proof of Concept) for their start-up applying their learnings from the CSBS course (core subjects + BCVS). The evaluation for this POC will be done as part of the		10 hours

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Sem end assessment by the TCS team. During the assessment, students need to share the journey of creating their start-up: from inception to POC		

19ECB342: ROBOTICS AND EMBEDDED SYSTEMS

L	T	P	C
2	0	2	3

This course introduces the student robotics and embedded systems. Embedded devices and communication buses is taught. Various program modeling concepts are discussed. Real time operating systems concepts, Multiprocessing, multitasking and Popular micro controllers are discussed. Robotics and Kinematics are introduced as well.

Course Outcome(s):

- To acquire knowledge about microcontrollers embedded processors and their applications.
- Ability to understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.
- Ability to understand the role of embedded systems in industry.
- Ability to understand the design concept of embedded systems.
- Design and engineer autonomous robots using various sensors

UNIT I **8L**

Introduction to Embedded System: Embedded system Vs General computing systems, History of Embedded systems, Purpose of Embedded systems, Microprocessor and Microcontroller, Hardware architecture of the real time systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret the Embedded system Vs General computing systems. (L2)
- analyze Microprocessor and Microcontroller. (L4)
- identify hardware architecture for the real time systems. (L3)

UNIT II **8L**

Devices and Communication Buses: I/O types, serial and parallel communication devices, wireless communication devices, timer and counting devices, watchdog timer, real time clock, serial bus communication protocols, parallel communication network using ISA, PCI, PCT-X, Internet embedded system network protocols, USB, Bluetooth.

Learning Outcomes:

At the end of this unit, the student will be able to

- compare various communication devices. (L2)
- analyze timer and counting devices. (L4)
- categorize embedded system network protocols. (L4)

UNIT III **8L**

Program Modelling Concepts; Fundamental issues in Hardware software co-design, Unified Modelling Language(UML), Hardware Software trade-offs DFG model, state machine programming model, model for multiprocessor system.

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate Unified Modelling Language(UML) . (L2)
- analyze various program models. (L4)
- interpret model for multiprocessor system. (L5)

UNIT IV **10L**

Real Time Operating Systems: Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, qualities of good RTOS.

Examples of Embedded System: Mobile phones, RFID, WISENET, Robotics, Biomedical Applications, Brain machine interface etc. Popular microcontrollers used in embedded systems, sensors, actuators.

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize RTOS. (L3)
- identify applications and interfaces. (L3)
- compare popular micro controllers.(L4)

UNIT V **8L**

Robotics: Introduction, Elements of robots -- joints, links, actuators, and sensors

Kinematics: Kinematics of serial robots, Kinematics of parallel robots, Motion planning and control

Advanced Topics on Robotics: Sensing distance and direction, Line Following Algorithms, Feedback Systems, Other topics on advance robotic techniques

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate elements of robots. (L2)
- apply kinematics of serial and parallel robots. (L3)
- classify advance robotic techniques. (L4)

Course Outcomes:

After the completion of this course, the student will be able to

- describe various microprocessors and micro controllers. (L2)
- identify hardware architecture for the real time systems. (L3)
- Distinguish communication protocols. (L4)
- classify various program model concepts. (L4)
- Identify applications and interfaces. (L3)
- develop various interface programs. (L6)

ROBOTICS AND EMBEDDED SYSTEMS LABORATORY

1. Arithmetic Operations using 8051
2. Interfacing ADC and DAC
3. Interfacing LED and PWM
4. Interfacing real time clock and serial port
5. Interfacing keyboard and LCD
6. Flashing of LEDS
7. Interfacing stepper motor and temperature sensor.
8. Study of robotic arm and its configuration
9. Study the robotic end effectors

Text Books:

1. Introduction to Embedded Systems : Shibu K. V. (TMH)
2. Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
3. Embedded Systems : Rajkamal (TMH)
4. Embedded Systems : L. B. Das (Pearson)
5. The 8051 Microcontroller and embedded systems by Muhammad Ali Mazidi, PHI.
6. Robotics: Fundamental Concepts and Analysis, Oxford University Press

Reference Books:

1. Embedded System design : S. Heath (Elsevier)
2. Embedded microcontroller and processor design: G. Osborn (Pearson)
3. Embedded systems design by Steve Heath, Newnes

19ECB344: MODERN WEB APPLICATIONS

L	T	P	C
2	0	2	3

This course enables the students to associate with developing websites for hosting via intranet or internet. The web development process includes web design, web content development, client-side scripting, server-side scripting. Web development is the coding or programming that enables website functionality as per the owner's requirements. It mainly deals with the non-design aspect of building websites, which includes coding and writing markup.

Course Objectives

- Design static web page using Markup languages and style sheets.
- Use of java script for designing web applications with dynamic effects.
- Validations on form input entry and adding dynamic content to web applications.
- Develop XML based web applications.
- The notions of Web servers and Design Methodologies with MVC Architecture.
- Develop application using recent environment like PHP and MYSQL

UNIT I **8L**

Introduction to Internet & World Wide Web:
History of the Internet & World Wide Web, Web Browsers, Web Servers, Uniform Resource Locator, Tools and Web Programming Languages. Web Standards, Categories of Web Applications, Characteristics of Web Applications, Tiered Architecture.

Hypertext Markup Language (HTML) Revision: Basic HTML page, Text Formatting, Table, Headers, Linking, Images, List, Meta Elements.

Cascading Style Sheets (CSS) Revision: Inline, Internal and External Style Sheet, Bootstrap-CSS Text , CSS forms , CSS components drop down .

Learning Outcomes:
After completion of this unit, the student will be able to

- outline various steps to design static websites. (L2)
- demonstrate the importance of HTML tags for designing web pages.(L2)
- distinguish the design from content using various levels of Style Sheets.(L4)

UNIT II **8L**

Java Script: Introduction to Java Scripts, Objects in Java Script, Dynamic HTML with Java Script, Bootstrap- JS, Alert, JS Button, JS popover.

Learning Outcomes:
After completion of this unit, the student will be able to

- design dynamic and interactive web pages by embedding Java script code in HTML.(L6)
- demonstrate validations of user input and perform dynamic documents. (L2)

UNIT III **8L**

Extensible Markup Language (XML):− Introduction, Structuring Data, Document Type Definition, XML Vocabularies, Document Object Model (DOM) with JavaScript, Extensible Stylesheet Language Transforms (XSL).

Learning Outcomes:

After completion of this unit, the student will be able to

- create XML documents and use java script to process data.(L6)
- develop application using XSLT environment.(L3)

UNIT IV **10L**

Writing Basic PHP Programs: Creating PHP Programs, Numbers and Strings, Literals and Variables, Operators and Functions.

Form & PHP: Creating Form Controls, Using Values Returned From, Forms Using PHP.

Learning Outcomes:

After completion of this unit, the student will be able to

- create a web Page by using Php script . (L6)
- interpret various functional concepts of Php. (L2)
- develop an Application by using Php. (L6)

UNIT V **8L**

PHP Database Connectivity: Connecting to MySQL Server, Selecting Databases, Checking for Errors, Closing the MySQL Server Connection.

Manipulating Data in MySQL Using PHP: Inserting, Viewing, Updating and Deleting Records, Manipulating joined tables.

User Authentication: Creating Session, Authorization Level.

Learning Outcomes:

After completion of this unit, the student will be able to

- demonstrate XAMPP/WAMP/LAMP installation and Database connection using different resources. (L2)
- create & deploy secure, usable database driven web applications (L6)

Course Outcomes:

After completion of this course, the student will be able to

- understand various steps to design dynamic websites.
- demonstrate the importance of HTML & DHTML tags for designing web pages and separate design from content using Cascading Style Sheet.
- design interactive web pages with client and server side scripting.
- apply validations on user input using Java script.
- analyze XML and XSLT documents
- create and deploy Web Applications over a web server.

TEXTBOOK(S):

1. DeitelP.J.,Deitel H.M.and Deitel A.(2012) Internet and World Wide Web: How to Program, Fifth Edition, Pearson Prentice Hall.
2. HTML & CSS: Design and Build Websites, Jon Duckett, John Wiley & Sons
3. Naramore E., Gerner J., Scouarnec Y.L., et al., (2005) Beginning PHP5, Apache, MySQL Web Development: Programmer to Programmer, John Wiley & Sons Inc., ISBN: 9780764579660.

REFERENCE(S):

1. Sebesta R.W.(2014)ProgrammingtheWorldWideWeb,8th edition,Pearson.
2. Pressman R.and Lowe D.(2008) Web Engineering: a practitioner's approach, First Edition, McGrawHill
3. Kappel G., et al. (2006) Web Engineering: The Discipline of systematic Development of Web Applications, First Edition, John Wiley & Sons.
4. Suh W.(2005)Web Engineering: Principles and Techniques, Idea GroupInc.
5. UllmanL(2016) PHP for the Web: Visual Quick Start Guide, Fifth Edition, Peachpit Press.

MODERN WEB APPLICATIONS LABORATORY

WEEK 1& WEEK 2:

Design the following static web pages required for an online bookstore web site.

1)HOME PAGE:

The static home page must contain three frames.

Top frame: Logo and the college name and links to Home page, Login page, Registration page, Catalogue page and Cart page (the description of these pages will be given below).

Left frame: At least four links for navigation, which will display the catalogue of respective links Foreg.:When you click the link "CSBS" the catalogue for CSBS Books should be displayed in the Right frame.

Right frame: The pages to the links in the left frame must be loaded here. Initially this page contains description of the website.

Logo	Web Site Name			
Home	Login	Registration	Catalogue	Cart
CSBS CSE ECE EEE CIVIL	Description of the Web Site			

Fig 1.1

2) LOGIN PAGE:

This page looks like below:

Logo	Web Site Name			
Home	Login	Registration	Catalogue	Cart

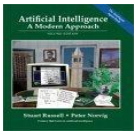
CSBS CSE ECE EEE CIVIL	Login: Password: Submit Reject

3) CATOLOGUE PAGE:

The catalogue page should contain the details of all the books available in the website in a tabular format.

The details should contain the following:

1. Snap shot of CoverPage.
2. BookTitle, AuthorName,Publisher.
3. Price.
4. Add to cart button.

Logo	WebSite Name			
Home	Login	Registration	Catalogue	Cart
CSBS ECE EEE CIVIL	   	Book: XMLBible Author :Winston Publication: Wiely Book: AI Author : S.Russel Publication: Princeton Hall Book: Java2 Author :Watson Publication:BPB publications Book: HTMLin 24hours Author :Sam Peter Publication:Sam publication	$ 40.5 $ 63 $ 35.5 $ 50	Add to cart Add to cart Add to cart Add to cart

WEEK 3 & WEEK 4:

4) CART PAGE:

The cart page contains the details about the books which are added to the cart. The cart page should look like this:

Logo	Web Site Name			
Home	Login	Registration	Catalogue	Cart
CSBS ECEE EECI VIL CSE	Bookname	Price	Quantity	Amount
	Java bible 2XML	$35.5	2	$70
		$40.5	1	$40.5
			Totalamount	$130.5

5) REGISTRATION PAGE:

Create a "registration form "with the following fields

1) Name (Textfield)
2) Password (password field)
3) E-mail id(textfield)
4) Phone number(textfield)
5) Sex(radio button)
6) Date of birth (3selectboxes)
7) Languages known (checkboxes–English,Telugu,Hindi,Tamil)
8) Address(textarea)

WEEK 5 & WEEK 6:

VALIDATION:

a) Write JavaScript to validate the following fields of the above registration page.

1. Name (Name should contains only alphabets and the length should not be less than 6 characters).
2. Password (Password should not be less than 6 characters length).
3. E-mail id (should not contain any invalid and must follow the standard

patternname@domain.com)

4. Phone number (Phone number should contain 10 digits only).

b) Write JavaScript to validate the above login page with the above parameters.

Design a web page using CSS (Cascading Style Sheets) which includes the following:

1) Use different font, styles:

   In the style definition you define how each select or should work (font, color etc.).Then, in the body of your pages, you refer to these selectors to activate the styles. For example:

```
<HTML>
<HEAD>
<style type="text/css">
B.headline {color:red;font-size:22px;font-family:arial;text-decoration:underline}
</style>
</HEAD>
<BODY>
<b>Thisis normalbold</b><br>
```

2) Seta background image for both the page and single elements on the page. You can define the background image for the page like this:

```
BODY {background-image:url(myimage.gif);}
```

3) Control the repetition of the image with the background-repeat property.

   As background-repeat:repeat
   Tiles the image until the entire page is filled, just like an ordinary background image in plain HTML.

4) Define styles for links as

   A: link A: visited A: active A: hover

   Example:

```
<style type="text/css">
A:link{text-decoration:none}A:visited{text-decoration:none}A:active{text-
   decoration:none}
A:hover{text-decoration:underline;color:red;}
</style>
```

5) Work with layers:For example:

LAYER 1 ON TOP:

LAYER1

<div style="position:relative;top:-50;left:5;color:red;font-size:80px;z-

LAYER 2 ON TOP:

LAYER1

<div style="position:relative;top:-50;left:5;color:red;font-size:80px;z-

6) Add a customized cursor:

Selector {cursor:value}For example:

```
<html>
<head>
<style type="text/css">
.xlink{cursor:crosshair}
.hlink{cursor:help}
</style>
</head>
<body>
<b>
<a href="mypage.htm" class="xlink">CROSS LINK</a>
```

WEEK 7 & WEEK 8:

Write an XML file which will display the Book information which includes the following:

a. Title ofthe book

b. AuthorName

c. ISBN number

d. Publishername

e. Edition

f. Price

Write a Document Type Definition (DTD)to validate the above XML file.Display the XML file as follows.

The contents should be displayed in a table. The header of the table should be in color GREY. And the Author names column should be displayed in one color and should be capitalized and in bold.Use your own colors for remaining columns.
Use XML schem as XSL and CSS for the above purpose.Note:Give atleastfor4 books. It should be valid syntactically. Hint: You can use some xmleditorslike XML-spy

WEEK 9 & WEEK 10:
Write Program in PHP to demonstrate basics of PHP
Convert all the previous forms to PHP forms.
Write a PHP Code to make database connection, Create Data Base, Create Table In Mysql
Write a program in PHP to perform CRUD(Create, InseRt, Update, Delete operations)
Study of Image Uploading in PHP Design A from which upload And Display Image in PHP

WEEK 11 & WEEK 12:
Install a database (Mysql).
Create a table which should contain at least the following fields: name, password, email-id, phone number (these should hold the data from the registration form).
Write a PHP code to connect to that database and extract data from the tables and display them. Experiment with various SQL queries.
Insert the details of the users who register with the web site, whenever a new user clicks the submit button in the registration page (week2).
Update user data, delete specific users

WEEK 13 & WEEK 14: Work on case study

TEXTBOOKS:

1. Web Programming, building internet applications, Chris Bates 2nd edition, WILEY Dreamtech.
2. HTML & CSS: Design and Build Websites, Jon Duckett, John Wiley & Sons
3. Naramore E., Gerner J., Scouarnec Y.L., et al., (2005) Beginning PHP5, Apache, MySQL Web Development: Programmer to Programmer, John Wiley & Sons Inc., ISBN: 9780764579660.

19ECB346: DATA MINING AND ANALYTICS

L	T	P	C
2	0	2	3

This course introduces the student data mining and analytics. The lecturer provides various ways for data analysis and its visualization. Some of the data analysis tools will be taught as practical to understand the data processing tasks for knowledge discovery. The dimensionality problem as well as its implication will be also taught.

Course objectives:

- Familiarize the student with various data mining techniques.
- Enable the student to represent the data in format for knowledge representation tasks.
- Familiarize the student with rule mining, classification and clustering.
- Introduce the various forecasting method for data analysis. .
- Introduce basic types of predictive analytics and its multi-objective.

UNIT I **8 L**

Introduction to Data Mining: What is data mining? Related technologies - Machine Learning, DBMS, OLAP, Statistics, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Applications

Learning Outcomes:

At the end of this unit, the student will be able to

- categorize the types of data (L2)
- data mining steps and its implementation. (L4)
- knowledge representation. (L6)

UNIT II **8 L**

Data preprocessing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Installing Weka 3 Data Mining System, Experiments with Weka - filters, discretization

Data mining knowledge representation: Task relevant data, Background knowledge, Representing input data and output knowledge, Visualization techniques

Attribute-oriented analysis: Attribute generalization, Attribute relevance, Class comparison, Statistical measures

Learning Outcomes:

At the end of this unit, the student will be able to

- data transformation and its representation. (L3)
- demonstrate one tool for data processing. (L2)
- understand the relevant and non-relevant attributes. (L4)

UNIT III **8 L**

Data mining algorithms - Association rules: Motivation and terminology, Example: mining weather data, Basic idea: item sets, Generating item sets and rules efficiently, Correlation analysis

Data mining algorithms - Classification: Basic learning/mining tasks, Inferring rudimentary rules: 1R, algorithm, Decision trees, covering rules

Data mining algorithms – Prediction: The prediction task, Statistical (Bayesian) classification, Bayesian networks, Instance-based methods (nearest neighbor), linear models

Learning Outcomes:

At the end of this unit, the student will be able to

- discover the rules. (L3)
- time complexity of data mining methods. (L3)
- knowledge representation using any algorithm like Nearest neighbor.(L4)

UNIT IV **8 L**

Descriptive analytics: Data Modeling, Trend Analysis, Simple Linear Regression Analysis

Forecasting models: Heuristic methods, predictive modeling and pattern discovery, Logistic Regression: Logit transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression, multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis. Interpreting Regression Models, Implementing Predictive Models

Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian, Gamma.

Non Linear Regression (NLS): Linearization transforms, their uses & limitations, examination of non-linearity, initial estimates, iterative procedures for NLS, grid search, Newton-Raphson, steepest descent, Marquardt's methods. Introduction to semiparametric regression models, additive regression models. Introduction to nonparametric regression methods

Learning Outcomes:

At the end of this unit, the student will be able to

- utilize various forecasting model. (L3)
- demonstrate any linear model like Poisson distribution. (L3)
- uses of non-linear model in data analysis.(L4)

UNIT V **10 L**

Time Series Analysis: Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, Holt – Winter smoothing, forecasting based on smoothing

Linear time series models: Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Estimation of ARMA models such as Yule-

Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARMA Processes, Forecasting using ARIMA models

Prescriptive Analytics: Mathematical optimization, Networks modeling-Multi-objective optimization-Stochastic modeling, Decision and Risk analysis, Decision trees.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the time series data set and its representation. (L3)
- step by step explanation of Linear time series model. (L2)
- classify the periodicity or uncertainty in time series data. (L4)

Course Outcome(s):

After completion of this course, the student will be able to

- understand basic concepts and techniques of Data Mining
- develop skills of using data mining software for solving practical problems
- understand and apply several statistical analysis techniques: regression, ANOVA, data reduction
- explain the rule mining techniques and its implementation.
- demonstrate the linear and non-linear models for data analysis.

DATA MINING AND ANALYTICS LABORATORY

List of Practical Experiments:

1. Implementation of any knowledge representation model.
2. Demonstration of a data visualization tool.
3. Implementation of rule mining and its implication for knowledge processing tasks.
4. Decision tree or next neighbor algorithm representations for data processing.
5. Explanation of linear or a non-linear data analysis method.
6. Mathematical representation of given data set for knowledge discovery tasks.

Home Assignments:

1. **Experiments with Weka** – Visualization Techniques, using filters and statistics, mining association rules, decision trees rules, Prediction
2. **Mining real data:** Preprocessing data from a real domain (Medical/ Retail/ Banking);Applying various data mining techniques to create a comprehensive and accurate model of the data
3. **Analytics Assignment 1:** Conduct and Present a summary report on an End to end statistical model building exercise using sample data – Data preprocessing, Descriptive Analysis (Exploratory Data Analysis), Hypothesis building, Model Fitting, Model Validation and Interpretation of results
4. **Analytics Assignment 2:** Build statistical models using any two linear and non-linear regression techniques: Simple Linear Regression; Multiple Regression; Variable Selection Problem; Multicollinearity and Ridge Regression; Nonlinear regression; Non-parametric regression; Logistic regression (binary and multiple); Poisson/Negative binomial regression (Use sample data sets)

Text Books:

1. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, 3rd ed, 2010.
2. Lior Rokach and Oded Maimon, “Data Mining and Knowledge Discovery Handbook”, Springer, 2nd edition, 2010
3. Box, G.E.P and Jenkins G.M. (1970) Time Series Analysis, Forecasting and Control, Holden-Day.

Reference Books:

1. Draper, N. R. and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third Edition.
2. Hosmer, D. W. and Lemeshow, S. (1989). Applied Logistic Regression (Wiley)

19EHS304: UNIVERSAL HUMAN VALUES: UNDERSTANDING HARMONY

L	T	P	C
2	1	0	3

Human Values Courses: During the Induction Program, students would get an initial exposure to human values through Universal Human Values -1. This exposure is to be augmented by this compulsory full semester foundation course.

Course objectives:

- Development of a holistic perspective based on self-explanation about themselves (human being), family, society and nature/existence
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection
- Development of commitment and courage to act

UNIT I **Course Introduction – Need, basic guidelines, content and process for value education** **8 L**

1. Purpose and motivation for the course, recapitulation from universal human values-1
2. Self-exploration-what is it? – Its content and process; 'Natural Acceptance' and Experimental Validation – as the process for self- exploration
3. Continuous happiness and prosperity – A look at basic human aspirations
4. Right understanding, relationship and physical facility – the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding happiness and prosperity correctly – A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and coexistence) rather than as arbitrariness in choice based on linking-dislinking.

UNIT II **Understanding harmony in the human being – harmony in myself?** **9 L**

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of self ('I') and 'Body' – happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body; Sanyam and health; correct appraisal of physical needs, meaning of prosperity in detail
6. Programs to ensure Sanyam and Health

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.
Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

UNIT III **Understanding harmony in the family and society-harmony in human-human relationship** **9 L**

1. Understanding values in human-human relationship; meaning of justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; trust and respect as the foundational values of relationship
2. Understanding the meaning of trust; difference between intention and competence
3. Understanding the meaning of respect, difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family); resolution, prosperity, fearlessness (trust) and co-existence as comprehensive human goals
5. Visualizing a universal harmonious order in society – undivided society, universal order – from family to world family

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discus with scenarios. Elicit examples from students' lives.

UNIT IV **Understanding harmony in the nature and existence – whole existence as coexistence** **9 L**

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc

UNIT V **Implications of the above Holistic Understanding of Harmony on Professional Ethics** **10 L**

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:

7. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
8. At the level of society: as mutually enriching institutions and organizations
9. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Text Books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakash an, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditS underlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - M aulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) Faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living. E.g. as a professional

Semester VII

S.No.	Course Code	Course	Category	L	T	P	C
1	19ECB431	Usability Design of Software Applications	PC	2	0	1	2.5
2	19ECB433	IT Workshop Skylab / Matlab	PC	1	0	4	3
3	19EID401	Financial Management	MS	2.5	0	0	2.5
4	19EID403	Human Resource Management	MS	2	0	0	2
5	19ECB4XX	Elective III	PE	2	1	2	4
6	19ECB45X	Elective IV	PE	2	1	2	4
7	19ECB491	Project Evaluation I	PW	0	0	2	1
Total				**19**			

19ECB431: USABILITY DESIGN OF SOFTWARE APPLICATIONS

L	T	P	C
2	0	1	2.5

Usability Design of Software Applications currently provide the best solutions to many problems. The purpose of this course is to study different models which will help in design of an adequate user interaction. In this course, students will be given an exposure to the user experience process of UX research and analysis, UX Design Creation, design Testing, and their implementation.

Course objectives:

- To create a learning system through which management students can enhance their innovation and creative thinking skills
- To acquaint themselves with the special challenges of starting new ventures
- To sensitise the students to the fundamentals of User Centred Design and User experience their relevance and contribution to businesses
- To use IPR as an effective tool to protect their innovations and intangible assets from exploitation
- Acquire the ability to constructively engage with the Design professionals they would work with in the future

UNIT I **Number of hours (LTP) 7**

Introduction to User Centred Design. Aspects of User Centred Design. Product Appreciation Assignment – Evaluating the product from user centred design aspects such as functionality, ease of use, ergonomics, aesthetics.

Learning Outcomes:

After completion of this unit, the student will be able to:

- basic knowledge and understanding of the user centre design (L2)
- understand the process of user centre design (L2)
- analyse and critique the design of interactive products (L4)

UNIT II **Number of hours (LTP) 8 6**

Heuristic Evaluation: 10 Heuristic Principles, Examples. Heuristic Evaluation: Group Assignment initiation (Website and App). Evaluation for key tasks of the app or website for heuristic principles, severity, recommendations. Group Assignment Presentations and reviews.

Learning Outcomes:

After completion of this unit, the student will be able to:

- analyze Usability Heuristics for User Interface Design (L4)
- identify and fix usability issues (L3)
- identify effective designs using heuristic evaluation (L3)

UNIT III **Number of hours (LTP) 9**

Group Project identification. Students will identify a project such as a website or mobile app to redesign. They will take this redesign project through the design lifecycle: Discovery, Define Design, Implement (Design Prototype), Usability Testing. The design methods and techniques will

be imparted w.r.t. the group project selected by the students.

Learning Outcomes:

After completion of this unit, the student will be able to:

- define the systems development life cycle (L1)
- redesign software application (L3)
- identify the entire product team's performance (L3)

UNIT IV **Number of hours (LTP) 9**

UX Research. Understanding users, their goals, context of use, environment of use. Research Techniques: Contextual Enquiry, User Interviews, Competitive Analysis for UX. Scenarios and Persona Technique. Presentation of Personas for the group project. Design Thinking Technique. Discovery and brainstorming

Learning Outcomes:

After completion of this unit, the student will be able to:

- design that are valuable to users (L3)
- design without making errors and efficient to use (L3)
- identify reliable evidence when making product changes (L3)

UNIT V **Number of hours (LTP) 9 6**

Concept Development. Task flow detailing for the Project. Prototyping Techniques. Paper, Electronic, Prototyping Tools.

Project Prototyping Iteration 1. Project Prototyping Iteration 2. Review and feedback. (Final presentation of solution – Exam)

Learning Outcomes:

After completion of this unit, the student will be able to:

- create ideas to solve specified design problems (L3)
- identify previously unknown issues and opportunities (L3)
- learn how to apply Usability design to solve real world software design problems (L3)

Text Books:

1. Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Jennifer Preece, Helen Sharp and Yvonne Rogers

Reference Books:

1. About Face, 4th Edition, Alan Cooper and Robert Reimann
2. Observing the User Experience, Second Edition: A Practitioner's Guide to User Research. Elizabeth Goodman, Mike Kuniavsky, Andrea Moed
3. The Elements of User Experience: User-Centered Design for the Web and Beyond. 2nd Edition, Jesse James Garrett
4. Understanding Design Thinking, Lean, and Agile - Jonny Schneider

Course Outcomes:

After completion of the course, the student will be able to:

- identify the appropriate User Centred Design and User Experience their significance and contribution to software applications (L3)
- understanding the facets of User Experience (UX) Design (L2)
- implementation of user research and solution conceptualization in the design and development lifecycle (L3)
- analyse and identify the methods to offer a better UI experience for the software applications (L4)
- knowledge in redesigning an existing Application of or better user experience (L5)

19ECB433: IT WORKSHOP SKYLAB/MATLAB

L	T	P	C
1	0	4	3

The purpose of this course is to learn and practice basic programming concepts, skills needed for basic problem solving, and applications-plots and built-in statistical and set operations, all using MATLAB as the vehicle. MATLAB is a powerful software package that has built-in functions to accomplish a diverse range of tasks, from mathematical operations to three-dimensional imaging. Additionally, MATLAB has a complete set of programming constructs that allows users to customize programs to their own specifications.

Course objectives:

- To Impart the Knowledge to the students with MATLAB software that enhances programming knowledge in Research and Development.
- To introduce the MATLAB technical computing environment for analysis and visualization of data to understand and predict future thinks.
- To introduce students to the use of a high-level programming language, MATLAB for solving scientific and engineering problems.
- Reinforce a structured, top-down approach to formulate and solve problems.
- Introduce common approaches, structures, and conventions for creating and evaluating computer programs, primarily in a procedural paradigm.

UNIT I Introduction to MATLAB Number of hours (LTP) 3 12

History, basic features, strengths and weaknesses, good programming practices and plan your code. Working with variables, workspace and miscellaneous commands: Creating MATLAB variables, overwriting variable, error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating-point number, managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands,

Learning Outcomes:

After completion of this unit, the student will be able to:

- highlight Strengths and Weaknesses of MATLAB (L1)
- understand the Programming Paradigm of MATLAB (L2)
- build and manage workspace (L3)
- identify errors and make corrections (L3)
- program with floating point numbers (L3)

UNIT II Matrix, Array and basic Mathematical Functions Number of hours (LTP) 3 0 12

Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing, creating a sub-matrix, dimension, matrix operations and functions matrix generators, special matrices, array and array operations, solving linear equations, other mathematical functions.

Learning Outcomes:

After completion of this unit, the student will be able to:

- define and tabulate the matrixes and vectors (L1)
- compose sub-matrices (L6)
- integrate and execute various operations on matrices (L3)
- solve linear equations using matrices (L6)
- define various mathematical functions/procedures (L1)

UNIT III Basic Plotting and Programming Number of hours (LTP) 3 0 12

Basic plotting: Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours.

Introduction to programming: Introduction, M-File Scripts, script-side effects, M-File functions, anatomy of a M-File function, input and output arguments, input to a script file, output commands.

Learning Outcomes:

After completion of this unit, the student will be able to:

- create simple plots with adding titles (L3)
- retrieve basic plotting concepts (L1)
- display axis labels and annotations (L3)
- test programming functions (L5)
- select input and output arguments (L1)

UNIT IV Control Flow and Operators Number of hours (LTP) 3 0 12

Control flow and operators: ``if ... end" structure, relational and logical operators, ``for ... end" loop, ``while ... end" loop, other flow structures, operator precedence, saving output to a file

Learning Outcomes:

After completion of this unit, the student will be able to:

- identify set of commands that repeats every time (L1)
- examine relations between I/O arguments (L3)
- direct computed values to store for future use (L6)
- manage various operations (L6)
- understand the flow of control (L1)

UNIT V Debugging M-files and Implementation of IPA Number of hours (LTP) 3 0 12

Debugging M-files: Debugging process, preparing for debugging, setting breakpoints, running with breakpoints, examining values, correcting and ending debugging, correcting an M-file. Implementation of various Image Processing Algorithms

Learning Outcomes:

After completion of this unit, the student will be able to:

- examine code for getting error fee (L3)
- identify bugs (L1)
- predict possibility of runtime errors (L2)
- calculate output values (L4)
- validate the arguments (L5)

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing MATLAB, Pearson Education Inc., 2004.
2. Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, Butterworth-Heinemann Publisher, 2013

Reference Books:

1. https://www.mathworks.com/content/dam/mathworks/mathworks-dot-com/moler/exm/book.pdf
2. https://www.mathworks.com/help/releases/R2014b/pdf_doc/matlab/getstart.pdf

Course Outcomes:

After completion of the course, the student will be able to:

- understanding, Building and managing workspace (L2)
- defining and composing matrices and submatrices to solve linear equations (L3)
- displaying axis labels and annotations, and testing programming functions (L3)
- examining relations between I/O arguments (L4)
- calculating and validating the arguments (L4)

List of Lab Experiments:

1. Basic Commands:
    i. Clear Command: Removes all variables from workspace.
    ii. clc Command: clears the command window and home the cudrsor.
    iii. help Command: help displays help about that Topic if it exist.
    iv. lookfor Command: Provides help by searching through all the first lines of MATLAB help topics and returning those that contains a key word you specify.
    v. edit Command: enable you to edit (open) any M-file in Editor Window. This command does not open built-in function like, sqrt. See also type Command.
    vi. more command: more on enables paging of the output in the MATLAB command window, and more off disables paging of the output in the MATLAB command window.
2. Create /initialize matrix by separate the elements of row with blanks or commas with some values and use semicolon to indicate the end of each row, and surround the entire list of elements with square brackets, [ ].
3. Display the result of addition, subtraction and multiplication operations on matrices.
4. Colon Operator: create and display vector using colon operator along with spacing, do some possible arithmetic operation and validate the result.
5. Create and display zero and unit matrix of required size.
6. Find and display the inverse and transpose of given matrix, find the largest element in each vector of the matrix and store at n+1 position of each row or vector, column and maximum element of the matrix at n+1, m+1 position, where n and m are size of the given matrix.
7. Display the result of the following commands/functions: diag(), prod(), median(), sort(), det(), tril(), and triu().
8. Write a program that display the result of various built-in functions like: abs (), atan(), ceil(), log(), rem() , sqrt(), rand(), randn() and mod() .
9. If you specify two vectors as arguments, Plot(x,y) produces a graph of y versus x. For example, create a vector of x values ranging from zero to 2*pi, compute the sine of these values and plot the result.
10. Display the above graph with proper labelling using xlabel, ylabel and title commands.
11. Plot Sinc function, where Sinc (x) = sin(x) / x, and $-2\pi \leq x \leq 2\pi$
12. Write a program in M-File to read 3 x 3 Matrix, then display the diagonal of matrix as shown below: The Diagonal of This Matrix = [ ]
13. Write a program to read a string, then replace each character in the string with its following character in ASCII code*.
14. Programs using control structure statements. For example, display all prime numbers between given two given input values.
15. Write a program to read an image and display the resulted image of the following commands: imresize() and imhist().

19EID401: FINANCIAL MANAGEMENT

L	T	P	C
2.5	0	0	2.5

This course is designed to provide fundamental knowledge on financial management. The course will introduce learners to - planning and acquisition of funds; effective utilization and allocation of the funds received or acquired; and distribution of profits in a business.

Course objectives:

- To provide understanding of essential terms, concepts and principles of financial theory
- To build the required skills and ability to apply principles of financial theory for corporate decision making
- To develop skills in students to use the techniques of financial planning and analysis

UNIT I Introduction to Financial Management **Number of hours (LTP) 9**

Introduction: Introduction to Financial Management - Goals of the firm - Financial Environments.
Time Value of Money: Simple and Compound Interest Rates, Amortization, Computing more that once a year, Annuity Factor.

Learning Outcomes:

After completion of this unit, the student will be able to:

- solve problems on future and present value of money in the context (L3)
- comprehend the linkage of finance function with other functions (L2)

UNIT II Risk and Return **Number of hours (LTP) 12**

Valuation of Securities: Bond Valuation, Preferred Stock Valuation, Common Stock Valuation, Concept of Yield and YTM.
Risk & Return: Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)

Learning Outcomes:

After completion of this unit, the student will be able to:

- solve problems on arriving at the value of various securities. (L3)
- apply to measure risk return in the context of portfolio (L3)

UNIT III Leverage and Cost of Capital **Number of hours (LTP) 12**

Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, Indifference Analysis in leverage study
Cost of Capital: Concept, Computation of Specific Cost of Capital for Equity - Preference – Debt, Weighted Average Cost of Capital – Factors affecting Cost of Capital 4L

Learning Outcomes:

After completion of this unit, the student will be able to:

- solve for Cost of Equity, Debt and Preference capital (L3)
- analyze operating, financial, and combined leverages for decision making (L4)

UNIT IV Capital Budgeting **Number of hours (LTP) 12**

Capital Budgeting: The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After Tax Incremental Operating Cash Flows,

Capital Budgeting Techniques, Project Evaluation and Selection - Alternative Methods

Learning Outcomes:

After completion of this unit, the student will be able to:

- analyze using capital budgeting techniques for decision making (L4)
- estimate cashflows for capital budgeting decisions (L3)

UNIT V Working Capital Management Number of hours (LTP) 15

Working Capital Management: Overview, Working Capital Issues, Financing Current Assets (Short Term and Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital.

Cash Management: Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.

Accounts Receivable Management: Credit & Collection Policies, Analyzing the Credit Applicant, CreditReferences, Selecting optimum Credit period.

Learning Outcomes:

After completion of this unit, the student will be able to:

- estimate working capital requirement (L3)
- prepare Cash Budgets (L5)
- propose a credit policy using the accounts receivable information (L5)
- solve for Operating cycle, Cash Conversion Cycle (L3)

Text Books:

1. Chandra, Prasanna - Financial Management - Theory & Practice, Tata McGraw Hill.

Reference Books: All latest available editions

1. Srivastava, Misra: Financial Management, OUP
2. Van Horne and Wachowicz: Fundamentals of Financial Management, Prentice Hall/ Pearson Education.
3. Jonathan Berk, Peter DeMarzo, and Ashok Thampi, Financial Management, Pearson Education in South Asia,
4. S, M Y Khan and P K Jain (8th ed.) McGraw Hill

Websites:

1. https://ocw.mit.edu/courses/sloan-school-of-management
2. Corporate Finance - Course (nptel.ac.in)

Course Outcomes:

After completion of the course, the student will be able to:

- understand the fundamental concepts of financial management (L2)
- apply the basic concepts such as time value of money, cost of capital, risk and return, working capital management, capital budgeting for effective decision making (L3)
- evaluate financial management decisions when applied to IT projects (L5)

19EID403: HUMAN RESOURCE MANAGEMENT

L	T	P	C
2	0	0	2

The general purpose of this course is to familiarize students with the basic principles and techniques of HRM. The course takes a practical view that integrates the contributions of the behavioral sciences with the technical aspects of implementing the HR function in the real world. This basic understanding of HRM is essential for the student when he enters into the diverse workplaces. The key objective of this course is to give an understanding that HR Management is more than just accepting employment applications and keeping records; it is a central and strategic organizational activity of increasing complexity and importance.

Course objectives:

- Comprehend in depth the theoretical framework and the basic principles of HRM
- Comprehend in depth functions of HRM (Job analysis, manpower planning, and recruitment, selection, on boarding, training & development, appraisal, compensation).
- Apply the principles and techniques of HRM gained through this course to the discussion of major personnel challenges and the solution of typical case problems

UNIT I Introduction to HRM Number of hours (LTP) 10

Human Resource Management: Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.

Pedagogy tools: Blended learning, Case let, video lectures, self-reading, corporate reports, and online tools for right engagement. (Menti Meter,Khoot)

Learning Outcomes:

After completion of this unit, the student will be able to:

- identify the difference between the traditional view of human resource management (HRM) and the present view. (L1)
- describe the HR challenges and Skills (L2)
- understand alternative approaches to managing human resources and appreciating the diversity of factors that motivate workers (L5)

UNIT II HR Systems Design Number of hours (LTP) 10

Human resource System Design: HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human Resources Accounting and Audit, Human Resource Information System.

Pedagogy tools: Case let, video lectures, self-reading, TED talks, Online dash boards for recruitment and selection, Guest lectures.

Learning Outcomes:

After completion of this unit, the student will be able to:

- describe the process of human workforce system design and identify why it is important to HRM. (L2)
- briefly discuss the line management responsibilities in HR Department. (L3)
- understand the concept of HRA, HR Audit and HRIS for the organizations (L1)

UNIT III Functional Areas of HRM Number of hours (LTP) 10

Functional Areas of HRM: recruitment and Staffing, Benefits, Compensation, Employee Relations, HR Compliance, Organizational Design, Training and Development, Human Resource Information System (HRIS) and payroll.

Pedagogy tools: Case let, video lectures, self-reading, Online survey and assessment, HR

executive Interviews.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand major difference between training and development and identify the common situations where training may be needed (L1)
- describe the concepts of recruitment and Selection for the right positions in the company (L5)
- understand about the Employee relations, HR Compliance for the better HR Functions (L2)
- understand the difference between basic and supplementary compensation (L2)

UNIT IV Human Resource Planning Number of hours (LTP) 10

Human Resource Planning: Demand Forecasting, Action Plans – retention, Training, Redeployment & Staffing, Succession Planning.

Pedagogy tools: Case let, video lectures, self-reading, Minor survey and report writing, Report analysis and Trend analysis on compensation, Industrial visit to know about the safety standards.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the concept of Human Resource Planning and forecasting methods of HRP (L1)
- evaluate the retention, training, redeployment and staffing function in the organization (L5)
- analyze the Role of supervisor for the succession planning at workplace (L4)

UNIT V Strategic Management of human Resources Number of hours (LTP) 10

Strategic Management of Human Resources: SHRM, Relationship between HR Strategy and Overall corporate strategy, HR as a factor of Competitive advantage, Managing Diversity in the workplace. Human Resource Management in Service Sector- Special considerations for Service Sector: Managing the Customer – Employee Interaction, Employee Empowerment and Customer Satisfaction, Service Failure and Customer Recovery – the Role of Communication and Training, Similarities and Differences in Nature of Work for the Frontline Workers and the Backend, Support Services - Impact on HR Practices Stressing Mainly on Performance and Flexible Working Practices – Implications for HR.

Pedagogy tools: Case let, video lectures, self-reading, Role plays, Group discussions, Discussions with Union/Welfare officer for industry exposure

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand how strategic HRM helps for organization effectiveness (L4)
- discuss about the relationship between HR Strategy and Corporate strategy. (L3)
- describe the managing diversity in the workplace. (L2)
- Understand about the HRM in Service sector (L2)
- Analyse the impact of HR Practices stressing on performance. (L4)

Text Books:

1. Gary Dessler & BijuVarkkey, "Human Resource Management", Pearson, New Delhi, 16th edition.
2. George W Bohlander, Scott A Snell, “Principles of human Resource Management”, Cengage Learning, 2017.16th edition.

3. Aswathappa, K., Human Resource and Personnel Management: Text & Cases, TMGH
4. Subba Rao, P., Personnel and Human Resource Management (Text & Cases), Himalaya Publishing House.

Reference Books:

1. Edwin B Flippo, "Personnel Management", Tata McGraw Hill Publishing, New Delhi, 1984
2. John H. Bernardin, "Human Resource Management - An Experiential Approach", Tata McGraw Hill, New Delhi, 2013
3. Mirza, Saiyadain, "Human Resource Management", Tata McGraw Hill, New Delhi, 2013
4. Gary Dessler&BijuVarkkey, "Human Resource Management", Pearson, New Delhi, 2015 14th edition.

Journal(s):

1. Harvard Business Review, Harvard Business School Publication USA
2. People Matters online Magazine
3. Human Capital Magazine
4. Vikalpa, Indian Institute of Management, Ahmedabad

Course Outcomes:

After completion of the course, the student will be able to:

- aware of the basic principles of Human Resource Management because success in today's complex business environment depends on effective management of its human resources (L2)
- familiarize the students with the basic concepts, roles, functional areas and activities of HR and help students understand organization's employees, their interest, motivation and satisfaction, and their belief of fair treatment (L3)
- know the HR Practices impact of the firm's current performance and sustainability in the long run (L4)

19ECB447: COGNITIVE SCIENCE AND ANALYTICS

L	T	P	C
2	1	2	4

Cognitive Science is the scientific study of mind and its processes. It is an interdisciplinary field that takes inputs from anthropology, artificial intelligence, linguistics, neuroscience, philosophy and psychology. Data Analytics is the science of analyzing raw data to make conclusions about that information. Analytics helps businesses optimize their performance. This course enables the students how to combine the concepts of Artificial Intelligence and Data Analytics under the name Cognitive Science and Analytics. The primary objective of this course is to provide an introduction to the basic principles and applications of cognitive science and analytics. Upon successful completion of the course, students will have an understanding of data types, data pre-processing, fundamentals of analytics, neuroscience and linguistics, applications of data analytics in various areas of Artificial Intelligence, Machine Learning and Deep Learning.

Course objectives:

- To study the categorization of data, statistical tools and emerging areas of analytics
- To learn the fundamentals of neuroscience and the concepts of language and linguistics
- To understand the categorization of relationship techniques and application of analytics
- To implement data analytics in various areas of Artificial Intelligence and Machine Learning
- To examine different approaches and methodologies in Artificial Intelligence, Machine Learning and Deep Learning

UNIT I Data theory, taxonomy of data and fundamentals of analytics **Number of hours (LTP) 6 4 4**

Data as a whole: Understanding of Data as a whole for distinguishing and relating various types of data and Categorization of Data: Structured, Unstructured Data, Quantitative & Qualitative Data.
Views of Data: Understanding Data as an interdisciplinary framework for learning methodologies: Covering statistics, neural networks, and fuzzy logic
Measurement & Scaling Concepts: Measurement of variables and commonly used statistical tools: Number of procedures for measurement of the variables,
Categorization procedures, Scale construction procedures and Techniques of data processing for qualitative as well as quantitative data;
Various types of Scales: Nominal, Ordinal, Interval & Ratio Scales
Introduction to Analytics: Definition, Description & Evolution of Analytics, History of Analytics, and Applicability of Analytics with development of Technology and Computer, How Analytics entered mainstream
Concepts of Analytics: Various overlapping concepts and fields of Analytics such as Data Mining, Machine Learning, Artificial Intelligence and Simulation
Emerging Areas in Analytics: Understanding of emerging research areas of Analytics: Mathematical programming, Evolutionary computation, Simulation, Machine learning/data mining, Logic-based models and Combinations of categories
Learning Outcomes:
After completion of this unit, the student will be able to:

- define various types and categories of data (L1)
- outline the measurement of variables and statistical tools (L2)
- demonstrate various types of scales (L2)
- explain evolution history and applicability of analytics L2)

- summarize various emerging research areas of analytics (L2)

UNIT II Foundational areas of cognitive science Number of hours (LTP) 6 4 4

Introduction & Evolution of Cognitive Science: Introduction to the study of cognitive sciences, Brief history of cognitive science development and Methodological concerns in philosophy

Understand Brain and Sensory Motor Information: Fundamentals of Neuroscience, Processing of sensory information in the brain and Brain Imaging Elements

Language & Linguistic Knowledge: Background and details of Syntax & Semantics, Understanding of Generative Linguistic

Memory & Processing: Theory of Information Processing, Fundamentals of Short-term Memory

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the study and history of cognitive science (L2)
- outline the fundamentals of neuroscience (L2)
- illustrate how the brain processes sensory information (L2)
- interpret the concepts of language and linguistic knowledge (L2)
- summarize information processing and the working of short-term memory (L2)

UNIT III Multivariate data analytics & cognitive analytics Number of hours (LTP) 6 4 4

Value Chain of Analytics: Descriptive Analytics Covering Exploratory Data Analysis & Basics of Statistics, Diagnostics Analytics: BI/Analysis, Trend, Pattern, Simultaneous Relationship, Predictive Analytics: Cause-Effect Relationship and Futuristic prediction in terms of probabilities, Continuous & Categorical Predictions, Simulation, Optimization, Multi-faceted Intelligent Technology driven Analytics combining Machine Intelligence with Human Brain Processing Abilities

Overview: High-level overview of Categorization of Techniques: Inter-dependence Relationship Techniques and Dependence Relationship Techniques

Overview of Commonly Used Inter-Dependence Techniques: Factor Analysis, Principal Component Analysis (PCA), Cluster Analysis

Overview of Commonly Use d Dependence Techniques: Regression, Logistic Regression

Analytics Value Chain & Application of Analytics across Value Chain:

a. Basic statistical concepts such as Descriptive & Diagnostics statistics, Concept of random variables, Discrete and continuous random variables, Confidence interval, Hypothesis testing, Analysis of variance and correlation.

b. Predictive analytics techniques such as Multiple linear regression, Logistic regression, Decision tree learning, Clustering and forecasting techniques.

c. Prescriptive analytics Concepts: Linear programming, Integer programming, Goal programming & Stochastic models

d. Cognitive analytics Concepts: Text Analytics, Learning Analytics, Data Mining, Cognitive Systems, Cognitive Computing, Learning Data Science, Machine Learning, Big data Analytics and Business analytics

Learning Outcomes:

After completion of this unit, the student will be able to:

- interpret the value chain of analytics (L2)
- contrast inter-dependence and dependence relationship techniques (L2)
- apply basic statistical concepts (L2)
- develop predictive analytics techniques such as linear programming (L3)
- make use of cognitive analytics concepts (L3)

UNIT IV Artificial intelligence & machine learning **Number of hours (LTP) 6 4 4**

Fundamentals of Artificial Intelligence: Various areas of AI:

a. Knowledge: Text Analytics, Topic Modelling, Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity Recognition (NER)
b. Perception: Image Analytics, Video Analytics & Audio Analytics
c. Memory: Cognitive Engagement: BOTs, Virtual & Digital Assistants, Augmented Reality, Virtual Reality, Mixed Reality
d. Learning: Intelligent Automation

Spectrum of AI

a. Reactive Machine: Low memory, works on Known rules, such as Object Detection/Games/Recommendations specific to known Rules
b. Limited Memory: Memory used to learn and improve continuously such as Most ML Models, Automated Vehicles
c. Theory of Mind: Machine Understands and responds such as BoTs/Virtual/Digital Assistants
d. Self-Aware: Human-like intelligence such as Super Robots in Space etc.

Learning Outcomes:

After completion of this unit, the student will be able to:

- outline knowledge as a fundamental concept of artificial intelligence (L2)
- extend the idea of perception to image, video and audio analytics (L2)
- explain the role of memory in cognitive engagement and learning (L2)
- illustrate reactive machines (L2)
- show the role of memory in implementing machine learning models and super robots (L2)

UNIT V Approach & methodology **Number of hours (LTP) 6 4 4**

World Standard Methodology: CRISP-DM Methodology, SEMMA Methodology

Real Life Work Around Multivariate Analytics: A few Selected Commonly Used Techniques: Predictive & Classification Models, Regression, Clustering

Real Life Work Around Artificial Intelligence, Machine Learning and Deep Learning: A few Selected Commonly Used Techniques & Algorithms: ANN (Artificial Neural Network), CNN (Convolutional Neural Network), RNN (Recurrent Neural Network)

RN Architecture: LSTM, Bidirectional LSTM, Gated Recurrent Unit (GRU), CTRNN (Continuous Time RNN)

CNN Architectures: VGG16, Alexnet, InceptionNet, RestNet, Googlenet

Object Detection models: R-CNN, Fast R-CNN, Faster R-CNN, Cascade R-CNN. Mask RCNN, Single Shot MultiBox Detector (SSD), You Only Look Once (YOLO), Single-Shot Refinement Neural Network for Object Detection (RefineDet), Retina-Net

Autoencoders: Denoising Autoencoder, GAN

Transformers: Attention based Encoder and Decoder: Eg: BERT (Bidirectional Encoder Representations from Transformers), Generative Pretrained Transformers GPT-3, GPT-2, BERT, XLNet, and RoBERTa

Learning Outcomes:

After completion of this unit, the student will be able to:

- analyze world standard methodologies like CRISP-DM and SEMMA (L4)
- examine a few multivariate analytics techniques (L4)
- compare a few machine learning and deep learning algorithms (L4)

- contrast various object detection models (L4)
- inspect a few types of autoencoders and transformers (L4)

Course Outcomes:

After completion of the course, the student will be able to:

- understand various types of data and fundamentals of analytics (L2)
- understand the fundamentals of neuroscience and linguistics (L2)
- classify relationship techniques and apply data analytics (L4)
- incorporate the analytics in various areas of Artificial Intelligence and Machine Learning (L3)
- study real life work around multivariate analytics and Artificial Intelligence, Machine Learning and Deep Learning (L3)

LAB EXERCISES:

Structured Data Analytics: Segmentation & Clustering, Classification & Prediction, Forecasting Association Mining & Sequence Mining

Textual Data Analytics: Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER) driven Analytics: Key Word Extraction, Text Summarization, Insight Generation

Image Analytics: Malaria/Carcinoma/COVID detection, Visual inspection for QA/QC

Video Analytics: Motion based Behavior Recognition, Behavioural Observations, and Parkinson's Disease Prediction

Audio Analytics: Speech to Text, Text to Speech, Transcript Services

Artificial Intelligence, Machine Learning driven Automation: Banking Process Automation, Hospital Triage Process Automation AR/VR enabled Guided Operations

Conversational Analytics: Artificial Intelligence, Machine Learning, Augmented Reality, Virtual Reality, Robotics, Digital/Virtual Assistant, Chat-BOT/ Program BOT, Email-BOT

Text Books:

Module I

1. Hall, P., Phan, W., & Whitson, K. (2016). Evolution of Analytics. O'Reilly Media Incorporated.
2. Cherkassky, V., & Mulier, F. M. (2007). Learning from data: concepts, theory, and methods. John Wiley & Sons.
3. The visual display of Quantitative Information: Edward Tufte, Graphics Press, 2001.
4. Scaling Measurement and Statistical Tools for Extension Workers by Krunal D. Gulkari, Hemant V. Borate, Mayur S. Shitap , 2016.

Module II

1. Cognitive Science: An Introduction to the Science of the Mind by José Luis Bermúdez
2. Cognitive Computing and Big Data Analytics by Judith S. Hurwitz (Author), Marcia Kaufman (Author), Adrian Bowles (Author)
3. Cognitive Science and Artificial Intelligence Advances and Applications: Authors: Gurumoorthy, Sasikumar, Rao, B Narendrakumar, Gao, Xiao-Zhi

Module III

1. Hall, P., Phan, W., & Whitson, K. (2016). Evolution of Analytics. O'Reilly Media Incorporated.

2. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.

3. Kumar, U. D. (2017). Business analytics: The science of data-driven decision making. Wiley.

4. Özköse, H., Arı, E. S., & Gencer, C. (2015). Yesterday, today and tomorrow of big data. Procedia-Social and Behavioral Sciences, 195, 1042-1050.

5. Gudivada, Venkat N., M. T. Irfan, E. Fathi, and D. L. Rao. "Cognitive analytics: Going beyond big data analytics and machine learning." In Handbook of statistics, vol. 35, pp. 169-205. Elsevier, 2016.

Module IV

1. Kao, A., & Poteet, S. R. (Eds.). (2007). Natural language processing and text mining. Springer Science & Business Media.
2. Demystifying Artificial intelligence: Simplified AI and Machine Learning concepts for Everyone (English Edition) Paperback – Import, 5 January 2021by Prashant Kikani
3. Kelleher, J. D., Mac Namee, B., & D'arcy, A. (2020). Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. MIT press.
4. Goodfellow, Ian, Yoshua Bengio, Aaron Courville, and Yoshua Bengio. Deep learning. Vol. 1, no. 2. Cambridge: MIT press, 2016.
5. Practical Deep Learning for Cloud, Mobile, and Edge: Real-World AI & Computer-Vision Projects Using Python, Keras & TensorFlow 1st Edition,
6. Conversational Chatbots for Analytics Third Edition by Gerardus Blokdyk
7. BORNET, P. B. (2020). Intelligent automation: Welcome to the world of hyperautomation. World Scientific Publishing Company.

Module V

1. Maimon, O., & Rokach, L. (Eds.). (2005). Data mining and knowledge discovery handbook.
2. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.
3. Zhang, C., & Ma, Y. (Eds.). (2012). Ensemble machine learning: methods and applications. Springer Science & Business Media.

Reference Books:

Module I

1. Seminal Paper: The evolution of analytics and implications for industry and academic programs MR Bowers, JD Camm, G Chakraborty - Interfaces, 2018 - pubsonline.informs.org.
2. Seminal paper: Shneiderman, B. (2003). The eyes have it: A task by data type taxonomy for information visualizations. In The craft of information visualization (pp. 364-371). Morgan Kaufmann.C: The Complete Reference, (Fourth Edition), Herbert Schildt, McGraw Hill.

Module II

Cognitive Analytics: Concepts, Methodologies, Tools, and Applications (4 Volumes) Information Resources Management Association (USA)A first course in Probability, S.M. Ross,Prentice Hall.

Module III

Seminal Paper: The evolution of analytics and implications for industry and academic programs MR Bowers, JD Camm, G Chakraborty - Interfaces, 2018 - pubsonline.informs.org.

PEDAGOGY:

MODULE I

1. Instructor-Led
2. Mini Assignments & Quiz

MODULE II

1. Instructor-Led
2. Mini Assignments & Quiz

MODULE III

1. Instructor-Led
2. Mini Assignments & Quiz

3. Industry Speakers

MODULE IV

1. Instructor-Led
2. Mini Assignments & Quiz
3. Industry Speakers

MODULE V

1. Instructor-Led
2. Mini Assignments & Quiz
3. Industry Speakers

19ECB449: INTRODUCTION TO IoT

L	T	P	C
2	1	2	4

This course will help students understand basic principles and concepts of Internet-of-Things use cases, applications, architecture, and technologies. Students will get an overview of an end-to-end IoT system encompassing the edge, cloud and application tiers. This course will build upon the foundations created in the pre-requisite courses and will equip the students to architect a complete IoT application on their own. The lab exercises will consist of hands-on experiments that will lead to building an IoT application end-to-end. Some of the specialized topics will be covered via student seminars where students are expected to research and present their findings in a seminar format.

Course objectives:

- Introduce basic concepts of IoT, and applications
- Familiarize the IoT based Architectures, Edge computing
- Demonstrating Edge Computing, Gateways, Data Processing
- Expose to different types of sensors
- Explain Networking and communication of IoT
- Introduction to various IoT Technologies
- Demonstrating Cloud applications, and protocols
- Summarizing Data Pre-processing

UNIT I Introduction to IoT Number of hours (LTP) 9

Introduction to IoT and Use cases: Understanding basic concepts of IoT, Consumer IoT vs Industrial Internet, Fundamental building blocks, Use Cases of IoT in various industry domains

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the concepts of IoT (L2)
- explain the IoT and its application (L2)
- explain internal units of IoT system (L2)
- understand various industry domains (L2)
- distinguish between Consumer IoT and Industrial (L2)

UNIT II Architecture Number of hours (LTP) 9

Architecture: IoT reference architectures, Industrial Internet Reference Architecture, Edge Computing, IoT Gateways, Data Ingestion and Data Processing Pipelines, Data Stream Processing

Learning Outcomes:

After completion of this unit, the student will be able to:

- design IoT architectures (L3)
- illustrate Industrial reference architectures (L2)
- explain edge computing (L2)
- understand the concepts of gateways (L2)
- understand and analyse Data processing (L2)

UNIT III Sensors and Industrial Systems Number of hours (LTP) 9

Sensors and Industrial Systems: Introduction to sensors and transducers, integrating sensors to sensor processing boards, introduction to industrial data acquisition systems, industrial control systems and their functions

Learning Outcomes:

After completion of this unit, the student will be able to:

- classify different sensors and transducers (L2)
- integrate sensors with IoT boards (L3)
- demonstrate Data Acquisition system (L3)
- explain Industrial Control System (L2)

UNIT IV Networking and Communication for IoT Number of hours (LTP) 9

Networking and Communication for IoT: Recap of OSI 7-layer architecture and mapping to IoT architecture, Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication), Industrial network protocols (Modbus, CANbus), Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP sockets, MQTT, WebSockets, protocols. Message encoding (JSON, Protocol Buffers)

Learning Outcomes:

After completion of this unit, the student will be able to:

- discuss the concepts of OSI model (L2)
- design OSI mapping with IoT architecture (L3)
- summarizes the network technologies (L2)
- analyse Cloud applications (L4)
- classify different protocols (L4)

UNIT V IoT Data Processing and Storage Number of hours (LTP) 9

IoT Data Processing and Storage: Time Series Data and their characteristics, time series databases, basic time series analytics, data summarization and sketching, dealing with noisy and missing data, anomaly and outlier detection

Learning Outcomes:

After completion of this unit, the student will be able to:

- examine IoT data processing (L4)
- summarize the time series and characteristics (L2)
- summarize data processing and sketching (L2)
- explain noisy and missing data (L2)
- understand anomalies in data processing (L2)

IoT Seminars:

Selected topics in IoT should be handled via student seminars. Recommended that students form a group do research on at least one of the following topics and present it through seminars. They are expected to do a literature survey of the topic and present their survey paper to the class. The suggested topics are –

a) **IoT Applications**
   - Smart Cities
   - Connected Vehicles and Telematics
   - Smart Grids
   - Smart Homes
b) **IoT data visualization**
c) **Survey of cloud based IoT platforms**
d) **Low power wide area networks for IoT**
e) **IoT device management**
f) **Survey of chips, embedded modules and development boards for IoT devices**
g) **Embedded and real-time operating systems for IoT**
h) **IoT Security**

- Security risks in IoT
- Securing IoT endpoint devices and secure communication protocols for IoT

Security and Privacy of IoT data

Text Books:

1. The Internet of Things, Samuel Greengard, MIT Press Essential Knowledge Series

Reference Books:

1. Industrial Internet Reference Architecture - http://www.iiconsortium.org/IIRA.htm
2. World Economic Forum Report on Industrial Internet of Things - https://www.weforum.org/reports/industrial-internet-things
3. 50 Sensor Applications for a Smarter World - http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
4. Visualizing Data-Exploring and Explaining Data with the Processing Environment, By Ben Fry, Publisher: O'Reilly Media
5. Raspberry Pi Computer Architecture Essentials, by Andrew K Dennis
6. Getting Started with Arduino, M. Banzi, O Reilly Media
7. GSMA IoT Security Guidelines & Assessment - https://www.gsma.com/iot/future-iot-networks/iot-security-guidelines/

Course Outcomes:

After completion of the course, the student will be able to:

- understand the fundamental concepts of IoT (L2)
- make use of IoT Architectures and data processing techniques (L3)
- apply Sensors, Transducers, and Data Acquisition system (L3)
- illustrate Network and IoT Communication technologies (L2)
- make use of data processing and dealing with noisy data (L3)

Lab Exercises:

1. Setting up the Arduino Development Environment, connecting analog sensors to an Arduino Boarding and reading analog sensor data
2. Digital Input and Output reading using and Arduino board and Arduino Development Environment
3. Integrate an Arduino Board to a Raspberry Pi computer and send sensor data from Arduino to the R Pi
4. Setup Python on the R Pi and run sample R Pi programs on the R Pi. Read the data from Arduino using Python language
5. Connect a R Pi Camera module to the Raspberry Pi and using Python programming capture still images and video
6. Set up TCP/IP socket server on a PC. Send a message from the R Pi to the PC using socket communication
7. Set up a MQTT broker on the PC. Send data from R Pi to PC using MQTT protocol. Receive data from PC to R Pi using MQTT protocol
8. Connect LED lights to an Arduino. Connect the Arduino to the R Pi. Send Message from PC to R Pi via MQTT protocol. On receipt of the message, toggle the LED lights on the Arduino
9. Set up an account in a cloud service (such as Google / AWS or Azure). Set up a simple Http server using a language of your choice. Push the image captured from the R Pi camera to this web service. On receiving the image, store the image in a database or file
10. Develop a mobile application to view the images captured by the R Pi camera

19ECB451: CRYPTOLOGY

L	T	P	C
2	1	2	4

The aim of this course is to introduce information security concepts to the students. This course develops a basic understanding of goals, threats, attacks and mechanisms, algorithms and their design choices. The course also familiarizes students with a few mathematical concepts used in cryptology. The course emphasizes to give a basic understanding of attacks in cryptosystems and how to shield information from attacks. It also deals with message authentication, Digital signatures.

Course objectives:

- Understand basics of security concepts and comprehend number theory required for implementing cryptographic algorithms
- Impart various cryptographic techniques
- Learn RSA and Digital-signature algorithms
- Study different security application to various e-commerce and payment sites
- Impart knowledge on Quantum security concepts

UNIT I **Number of hours (LTP) 9**

Introduction to Cryptography: Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems.

Basic security services: confidentiality, integrity, availability, non-repudiation, privacy

Learning Outcomes:

After completion of this unit, the student will be able to:

- illustrate different security attacks (L2)
- apply classical substitution methods (L3)
- learn basic math required for implementing cryptographic methods (L2)

UNIT II **Number of hours (LTP) 9**

Symmetric key cryptosystems: Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC; Block Ciphers: DES, AES, Modes of Operation; Hash Functions; Authentication

Learning Outcomes:

After completion of this unit, the student will be able to:

- distinguish block and stream ciphers (L2)
- explain working of block cipher DES and AES algorithm (L2)
- discuss working of stream cipher RC4 (L2)

UNIT III **Number of hours (LTP) 9**

Public Key Cryptosystems: RSA, ECC; Digital signatures

Learning Outcomes:

After completion of this unit, the student will be able to:

- illustrate the concepts of Elliptic curve cryptography (L2)
- program RSA algorithm using suitable programming language (L4)
- explain Digital signature methods (L2)

UNIT IV **Number of hours (LTP) 9**

Security Applications (Selected Topics): Electronic commerce (anonymous cash, micro-

payments), Key management, Zero-knowledge protocols, Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the necessity of security applications for various applications (L2)
- learn the issues related to Quantum Cryptanalysis (L2)
- learn how to trace applications security (DSS) (L2)

UNIT V **Number of hours (LTP) 9**

Introductory topics in Post-Quantum Cryptography: Refer to https://csrc.nist.gov/projects/post-quantum-cryptography. May discuss any two ciphers from this list.

Learning Outcomes:

After completion of this unit, the student will be able to:

- learn about Quantum cryptography (L2)
- discuss about ciphers that use quantum cryptography (L2)

Text Books:

1. Cryptography, Theory and Practice. D R Stinson, CRC Press.
2. Handbook of Applied Cryptography, A J Menezes, P C Van Oorschot and S A Vanstone, CRC Press.

Reference Books:

1. A course in number theory and cryptography. N Koblitz, GTM, Springer.
2. Cryptography and Network Security, W Stallings, Prentice Hall
3. Security Engineering, R Anderson, Wiley
4. RC4 Stream Cipher and its variants, G Paul and S Maitra: CRC Press, Taylor and Francis group, A Chapman & Hall Book, 2012.
5. Design & Cryptanalysis of ZUC – A Stream Cipher in Mobile Telephony, C S Mukherjee, D Roy, S Maitra, Springer 2020
6. Contact Tracing in Post-Covid World – A Cryptologic Approach P Chakraborty, S Maitra, M Nandi, S Talnikar, Springer 2020
7. Preskill Lecture notes: Available online: http://www.theory.caltech.edu/`preskill/ph229/

Course Outcomes:

After completion of the course, the student will be able to:

- illustrate working of basic encryption techniques (L3)
- describe the working of symmetric encryption techniques (L2)
- experiment the working of algorithms such as RSA, DSA (L3)
- learn security application for various e-commerce and other applications (L3)
- learn basic Quantum computing ciphers (L2)

19ECB453: QUANTUM COMPUTATION AND QUANTUM INFORMATION

L	T	P	C
2	1	2	4

Quantum computing is an interdisciplinary field that lies at the intersection of computer science, mathematics, and physics. This computational paradigm relies on principles of quantum mechanics, such as superposition and entanglement, to obtain powerful algorithms. Quantum Information and Computation exploits quantum mechanical rules to process information. It has both fundamental and technological implications. This course will start with an overview of quantum computation and quantum information.

Course objectives:

- To understand the fundamental concepts on quantum computing.
- To understand foundations of quantum mechanics such as measurement theory, interaction with environment and the role of entanglement
- Studying the structural units of quantum computers of the future, forming an understanding of the differences between quantum bits and classical bits.
- To learn how to do computation using quantum algorithms
- To process secure information in various modern-day applications

UNIT I Introduction to Quantum Information Number of hours (LTP) 8 2 2

Qubits, States, Operators, Measurements, Quantum Entanglement, Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits.

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the concept of qubits, as an equivalent to 'bits' in classical computation (L2)
- visualize the notion of the 'state' of a qubit, as a vector in a 2-dimensional vector space (L3)
- 'measure' a qubit, and the probabilities associated with these measurements (L3)
- apply quantum computing concepts in Quantum teleportation, Super-dense coding and CHSH Game (L3)
- demonstrate how a Quantum Computer can be materialized using Quantum gates and circuits (L3)

UNIT II Quantum Algorithms Number of hours (LTP) 9 2 2

Deutsch-Jozsa, Simon, Grover, Shor, Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems, Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems.

Learning Outcomes:

After completion of this unit, the student will be able to:

- illustrate how Deutsch-Jozsa algorithm works on the classic Deutsch's problem (L2)
- Illustrate the implementation and execution of Simon's and Grover's quantum algorithms (L2)
- explain the implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems (L2)
- illustrate how Shor's algorithm is used for factorizing a number (L2)
- explain the importance of Shor's algorithm in factorization and Discrete Logarithm based classical public key cryptosystems (L2)

UNIT III **Quantum True Random Number Generators (QTRNG)** **Number of hour s(LTP) 7 2 1**

Detailed design and issues of quantumness, Commercial products and applications.

Learning Outcomes:

After completion of this unit, the student will be able to:

- generate perfectly unpredictable random numbers to ensure the strongest level of encryption (L3)
- understand the applicability of quantum computing in practical cases (L2)
- know different user applications of quantum computing (L2)

UNIT IV **Quantum key distribution (QKD)** **Number of hours (LTP) 8 2 1**

BB84, Ekert, Semi-Quantum QKD protocols and their variations, Issues of Device Independence, Commercial products.

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain how quantum key distribution protocols like BB84 (proposed by Bennett and Brassard, 1984) and E91 (proposed by Ekert, 1991) work (L2)
- explain the working of semi-quantum key distribution protocols and variations (L2)
- explain the issues / challenges of device independence in quantum key distribution (L2)
- give examples of commercial products that use QKD protocols (L2)

UNIT V **Introductory topics in Post-Quantum Cryptography** **Number of hours (LTP) 6 2 2**

Challenges that quantum computing poses to cryptography, Any two algorithm techniques from this list: Lattice-based cryptography, Lattice-based cryptography, Multivariate cryptography, Hash-based cryptography, Code-based cryptography

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the challenges that cryptography is facing after the emergence of quantum computing (L2)
- illustrate any two algorithm approaches for post-quantum cryptography, from these five: Lattice-based cryptography, Lattice-based cryptography, Multivariate cryptography, Hash-based cryptography, Code-based cryptography (L2)

Text Books:

1. *Quantum Computation and Quantum Information.* M. A. Nielsen and I. L. Chuang, Cambridge University Press, 10th anniversary edition, 2010.
2. Presskil Lecture notes: Available online, http://www.theory.caltech.edu/~preskill/ph229/

Reference Books:

1. *An Introduction to Quantum Computing.* P. Kaye, R. Laflamme, and M. Mosca,
   a. Oxford University Press, New York.
2. *Quantum Computer Science.* N. David Mermin, Cambridge University Press.
3. *Quantum Cryptography.* D. Unruh: Available online:
   a. https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/
4. NIST Post Quantum Cryptography, Available online:
   a. https://csrc.nist.gov/projects/post-
   b. quantum-cryptography/round-2-submissions
5. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ
   a. Experience. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer

2020.
6. Quantum Algorithm Zoo. https://quantumalgorithmzoo.org/
7. Handbook of Applied Cryptography. A. J. Menezes, P. C. van Oorschot, and S. A.
    a. Vanstone. CRC Press

Course Outcomes:

After completion of the course, the student will be able to:

- explain the working, architecture and program model of a quantum computer (L2)
- interpret and make use of quantum logic gate circuits (L3)
- make use of several quantum algorithms (L3)
- experiment with quantum algorithm on major toolkits (L3)

Coursera courses:

1. https://www.coursera.org/learn/quantum-computing-lfmu
2. https://www.coursera.org/learn/physical-basis-quantum-computing
3. https://www.coursera.org/learn/quantum-computing-algorithms
4. https://www.coursera.org/specializations/quantum-computing-from-basics-to-the-cutting-edge

List of Experiments:

1. Implementation of Shor's Algorithms
2. Implementation of Grover's Algorithm
3. Implementation of Deutsch's Algorithm
4. Implementation of Deutsch-Jozsa's Algorithm
5. Quantum Simulation as a Search Algorithm (https://qiskit.org/textbook/ch-labs/Lab07_QuantumSimulationSearchAlgorithm.html)
6. Quantum Error Correction (https://qiskit.org/textbook/ch-labs/Lab08_QEC.html)
7. Quantum Coin Game (https://qiskit.org/textbook/ch-demos/coin-game.html)
8. Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm

19ECB455: ADVANCED SOCIAL, TEXT AND MEDIA ANALYTICS

L	T	P	C
2	1	2	4

This course focuses on the research design and data analysis tools used to explore and understand social media and text data. The fundamentals of research design are the same throughout the social sciences, however the topical focus of this class is on computationally intensive data generating processes and the research designs used to understand and manipulate such data at scale. The course will provide students with the tools to design observational studies and experimental interventions into large and unstructured data sets at increasingly massive scales and at different degrees of computational complexity

Course objectives:

- To be able to use various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling
- Explore the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales – ranging from small groups to the World Wide Web
- Perform social network analysis to identify important social actors, subgroups (i.e., clusters), and network properties in social media sites such as Twitter, Facebook, and YouTube
- Defining goals and evaluating outcomes of Network Analysis.
- Students should analyze the social media and applications

UNIT I Text Mining Number of hours (LTP) 9

Text Mining: Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications

Methods & Approaches: Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modeling; Sentiment Analysis; Sentiment Prediction

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the basics of text mining and clustering (L2)
- analyse text mining Operations (L4)
- understand various preprocessing techniques (L2)

UNIT II Web Analytics Number of hours (LTP) 9

Web Analytics: Web analytics tools, click stream analysis, A/B testing, online surveys; Web search and retrieval, Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the various probabilistic models for information extraction. (L2)
- interpret the content analysis of text mining (L2)
- analyse Natural Language Processing and its content with application of txt mining (L4)

UNIT III Social Media Analytics Number of hours (LTP) 9

Social Media Analytics: Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization.

Learning Outcomes:
After completion of this unit, the student will be able to:

- explore the web analytical tools (L3)
- analyse the web search and retrieval optimization engines (L4)
- understand ranking algorithm and the models of web traffic (L2)

UNIT IV Social Networks Number of hours (LTP) 9

Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity; Social network analysis

Learning Outcomes:
After completion of this unit, the student will be able to:

- summarize the social media analytics and web data methods (L2)
- develop graphs and matrices for social media analytics (L3)
- visualize the web data models with information (L3)

UNIT V Facebook Analytics Number of hours (LTP) 9

Introduction, parameters, demographics, Analysing page audience, Reach and Engagement analysis, Post performance on FB, Use of Facebook Business Manager, defining goals and evaluating outcomes, Network Analysis. (LinkedIn, Instagram, YouTube Twitter etc).

Case study: Students should analyse the social media of any ongoing campaigns and present the findings.

Learning Outcomes:
After completion of this unit, the student will be able to:

- understand the parameters, demographics and page audience for Facebook (L2)
- analyse the post-performance on FB and network analysis (L4)
- identify important social actors, subgroups (i.e., clusters), and network properties in social media sites such as Twitter, Facebook, and YouTube (L3)

Text Books:

1. Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.
2. Avinash Kaushik. 2009. Web Analytics 2.0: The Art of Online Accountability.
3. Hanneman, Robert and Mark Riddle. 2005. Introduction to Social Network Method
4. Hansen, Derek, Ben Sheiderman, Marc Smith. 2011 Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 304

Reference Books:

14. Wasserman, S. & Faust, K. (1994). Social network analysis: Methods and applications. New York: Cambridge University Press.
15. Monge, P. R. & Contractor, N. S. (2003). Theories of communication networks. New York: Oxford University Press. http://nosh.northwestern.edu/vita.html

Course Outcomes:
After completion of the course, the student will be able to:

- be able to use various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling (L3)
- explore the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales – ranging from small groups to the World Wide Web (L4)

- perform social network analysis to identify important social actors, subgroups (i.e., clusters), and network properties in social media sites such as Twitter, Facebook, and YouTube (L4)
- define goals and evaluate outcomes of Network Analysis (L5)
- analyze the social media and Applications (L4)

Home Assignments:

1. **Language Analysis:** Students are expected to analyze the language of a category of text (e.g., literary, academic, social media) of their selection. Based on the analysis, students are expected to provide a critical description of the texts involved and possibly distinguishing them from other texts and/or uncovering relationships or concepts communicated by the text authors.
2. Students are required Perform sentiment analysis using Twitter. Students will be required to use off the-shelf software and/or code of their own to detect sentiment/emotion in the data and write a description of the methods they use and the results.

List of Experiments:

1. What is SPSS? Create the tables for graphs for one application (suggested by the instructor)
2. How the Data was represented in HTML, XML, JSON, CSV With example
3. What is text analytics? In business? identify any two tools
4. Reading and Writing with Text Files and Binary Files
5. Adding Text to Graphs
6. How to collect data from Twitter and YouTube with the help of Application
   Case study 1: will involve doing sentiment analysis with Python.
   Case study 2: second case study will take us through basic text mining application using R.
   We wrap up the unit with a conclusion of what we did in this course and where to go next for
7. Further learning and exploration.
8. Analyzing and visualizing the data from various social media services

19ECB457: MOBILE COMPUTING

L	T	P	C
2	1	2	4

This course will cover the nomenclature and implementation of mobile computing and mobile communication. Coverage mobile systems will include 2G, 2.5G, 3G, 3G+, and 4G communication systems, mobile IP. This course will also provide a systematic explanation of mobile computing as a discrete discipline and will provide an in depth of ad-hoc and sensor networks, radio networks and 5G cellular networks.

Course objectives:

- To provide students an overview of the basics and issues in mobile computing.
- To familiarize the students with the various mobile communication mechanisms.
- To make them understand the importance of applications of mobile computing.
- To study the specifications and functionalities of various mobile adhoc networks and sensor networks.
- Learn about cognitive radio networks and D2D communication in 5G cellular networks

UNIT I **Number of hours (LTP) 8 6**

Introduction: Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cellsplitting; Channel assignment strategies; Overview of generations: - 1G to 5G.

Learning Outcomes:

After completion of this unit, the student will be able to:

- familiarize the fundamentals of mobile infrastructure and cellular architecture (L2)
- analyse the concepts of Radio resource management, Propagation and path loss models (L4)
- understand the evolution of different generations of network (L2)

UNIT II **Number of hours (LTP) 10 6**

Location and handoff management: Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based); Mobility models characterizing the movement of groups of nodes (Reference point based group mobility model, Community based group mobility model); Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the fundamentals of mobility model (L2)
- illustrate the different dynamic location management schemes (L2)
- summarize the various handoff process (L3)

UNIT III **Number of hours (LTP) 8 6**

Wireless transmission fundamentals: Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain;

Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA, CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and zigbee).

Learning Outcomes:

After completion of this unit, the student will be able to:

- describe the fundamentals of Wireless transmission (L1)
- analyse the concepts of MIMO (L4)
- illustrate and summarize the Multiple access control techniques (L2)

UNIT IV **Number of hours (LTP) 8 6**

Mobile Ad-hoc networks: Characteristics and applications; Coverage and connectivity problems; Routing in MANETs.

Wireless sensor networks: Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).

Learning Outcomes:

After completion of this unit, the student will be able to:

- describe the characteristics and applications of MANETs (L1)
- explore the concepts of Wireless sensor networks (L2)
- understand the connectivity, energy consumptions and routing algorithms (L3)

UNIT V **Number of hours (LTP) 8 6**

Cognitive radio networks: Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks.

D2D communications in 5G cellular networks: Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Milli-meterwave communication in 5G.

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the overview of Cognitive Radio Networks (L2)
- describe D2D communications in 5G cellular networks (L1)
- summarize the concepts of radio resource management and Milli-meterwave communication in 5G (L2)

Text Books:

1. Jochen Schiller, “Mobile Communications”, Pearson Education.
2. Andrea Goldsmith,” Wireless Communications”, Cambridge University Press.

Reference Books:

1. Theodore Rappaport,” Wireless Communications: Principles and Practice”, Pearson Education.
2. Ezio Biglieri, MIMO,” Wireless Communications”, Cambridge University Press.
3. Ivan Stojmenovic,” Handbook of Wireless Networking and Mobile Computing”, Wiley
4. James Cowling,” Dynamic Location Management in Heterogeneous Cellular Networks”.
5. Gordon L. Stber,” Principles of Mobile Communication”, Springer.
6. Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain,” Wireless Device-to-DeviceCommunications and Networks”, Cambridge University Press.
7. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor,” Principles of Cognitive Radio”, Cambridge University Press.
8. Edgar H. Callaway, Jr. and Edgar H. Callaway,” Wireless Sensor Networks: Architectures

and Protocols", CRC Press.

Web References:

1. MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
2. Location Management in Wireless Cellular Networks. Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
3. *A Discrete-Event Network Simulator.* https://www.nsnam.org/docs/manual/html/index.html

Course Outcomes:

After completion of the course, the student will be able to:

- understand the basic concepts of mobile computing (L2)
- apply the basics of mobile telecommunication systems (L3)
- classify the generations of telecommunication systems and transmission in wireless networks (L2)
- compare the basic concepts of mobile Ad-hoc networks and Wireless sensor networks (L4)
- discuss the basic concepts of cognitive radio networks and 5G networks (L4)

List of Experiments:

1. Program in NS3 for connecting three nodes considering one node as a central node.
2. Program in NS3 to implement FTP using TCP bulk transfer.
3. Program in NS3 for connecting multiple routers and nodes and building a hybrid topology and then calculating network performance
4. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
5. Implement and study the performance of CDMA on NS3 (Using stack called Call net) or equivalent environment
6. To study Network Simulator (OMNET++) and its Installation & Create a Simple Module using two sub modules and show massage passing between them using OMNET ++.
7. To improvise the graphics & add a debugging message to module in OMNET.
8. To add a delay of 100ms & add a counter that automatically terminate the message passing after reaching zero.
9. To Add parameter in your module such that the value of counter should be received from ned and ini file.
10. Create a ned file for complex network having more that 2 sub-modules in omnet++. Also change the graphics & odd delay. Create a source file for complex network having more that 2 sub-modules using omnet++.

19ECB491: PROJECT EVALIUATION I

L	T	P	C
0	0	2	1

Project is a short project intended to train students to identify a problem of practical significance and are expected to accomplish the following activities:

i) Abstract
ii) Introduction
iii) Literature Review
iv) Problem Identification and Objectives
v) System Methodology
vi) Overview of Technologies

and submit a report.

The project can be an individual or maximum of four persons.

Semester VIII

S.No.	**Course Code**	**Course**	**Category**	**L**	**T**	**P**	**C**
1	19EID432	Services Science & Service Ops Management	MS	3	0	2	4
2	19ECB432	IT Project Management	MS	3	0	2	4
3	19EID402	Marketing Research and Marketing Management	MS	2	0	0	2
4	19EXX46X	Elective V	PE	3	0	2	4
5	19EXX47X	Elective VI	PE	3	0	2	4
6	19ECB492	Project Evaluation II	PW	0	0	2	1
Total				**19**			

19EID432: SERVICES SCIENCE & SERVICE OPS MANAGEMENT

L	T	P	C
3	0	2	4

This course explores key issues in service strategy, service design and service delivery, and successful ways to manage them as demonstrated by world-class companies. In this course, most emphasis will be placed on what are often referred to as "mass services" or "business-to-consumer" services. this course is to explore the characteristics of customer and operations management which are specific to services, to be applied in a traditional service company or in a service department of any company.

Course Pre-Requisite(s):

Fundamentals of Management, Operations Research

Course objectives:

- This course examines the management of services focusing on both the strategic and operational aspects of designing new services
- Helps in assessing and improving service quality, improving the efficiency and effectiveness of service processes
- Helps in understanding the integration of new technologies into service operations

UNIT I Introduction to services Number of hours (LTP) 9 6

Introduction: Introduction to the course, introduction to service operations, role of service in economy and society, introduction to Indian service sector.

Nature of Services and Service Encounters: Differences between services and operations, service package, characteristics, various frameworks to design service operation system, kind of service encounter, importance of encounters

Service-Dominant Logic: Goods-Dominant logic to Service-Dominant logic, Value Co-creation.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understanding the nature of services (L2)
- managing human resource in services (L3)
- understand and be able to explain the critical perspectives on the nature of service (L2)

UNIT II Service Design Number of hours (LTP) 9 6

Service Strategy and Competitiveness: Development of Strategic Service Vision (SSV), Data Envelopment Analysis

New Service Development: NSD cycle, Service Blueprinting, Elements of service delivery system

Service Design: Customer Journey and Service Design, Design Thinking methods to aid Service Design

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand and be able to apply a range of methods for assessing the needs, expectations and perceptions of customers (L2)
- aligning service strategy and service competitiveness (L3)
- explain and apply the principles, tools, and techniques of service design (L3)

UNIT III Quality and Yield Number of hours (LTP) 8 6

Management

Locating facilities and designing their layout: models of facility locations (Huff's retail model), Role of service-scape in layout design

Service Quality: SERVQUAL, Walk through Audit, Dimensions of Service quality & other quality tools

Service Guarantee & Service Recovery: How to provide Service guarantee? How to recover from Service failure?

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain the methods with which organisations can measure their service performance (L2)
- demonstrate how organisations can deal with challenges such as customer complaints and service failures (L2)
- demonstrate ways in which organizations are changing what they do through innovative uses of technology and discuss the implications of these changes (L2)

UNIT IV **Forecasting, Managing Capacity, and facilities** **Number of hours (LTP) 8 6**

Forecasting Demand for Services: A review of different types of forecasting methods for demand forecasting.

Managing Capacity and Demand: Strategies for matching capacity and demand,Psychology of waiting, Application of various tools used in managing waiting line in services.

Managing Facilitating Goods: Review of inventory models, Role of inventory in services

Learning Outcomes:

After completion of this unit, the student will be able to:

- understanding of the key operational levers that can be applied to the management of service operations (L2)
- describe ways in which technology is providing innovations in service activities (L2)
- managing waiting lines & queuing models (L3)

UNIT V **Service Supply, Queuing Models, Service Innovation** **Number of hours (LTP) 8 6**

Managing service supply relationship: Understanding the supply chain/hub of service, Strategies for managing suppliers of service

Vehicle Routing Problem: Managing after sales service, understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes.

Service Innovation: Services Productivity, Need for Services Innovation

Learning Outcomes:

After completion of this unit, the student will be able to:

- apply modeling techniques to service activities and demonstrate ability to use modelling techniques (L3)
- apply theories that are emerging in service science and identify current limitations in applying those theories (L3)

Text Books:

1. Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Information Technology, 2019, 9th edition, McGraw Hill publications.

Reference Books:

1. Wilson, A., Zeithaml, V. A., Bitner, M. J., &Gremler, D. D. Services marketing: Integrating customer focus across the firm. 2012. McGraw Hill publications
2. Reason, Ben, and Lovlie, Lavrans, Service Design for Business: A Practical Guide to Optimizing the Customer Experience, 2016, Pan Macmillan India

Course Outcomes:

After completion of the course, the student will be able to:

- understand concepts about Services and distinguish it from goods (L2)
- identify characteristics and nature of Services (L3)
- comprehend ways to design Services and evaluate them using Service qualities (L2)
- understand various methods to be used to operate and manage Service businesses (L2)
- understand how innovation can be approached from services point of view 6 (L2)
- familiar with the tools and techniques used for designing and managing the service operations (L3)

Student Project:

Option 1: Choose any service organization around and present it from the perspective of: nature of service, classification of service, blueprint or service design analysis, service quality, and any additional perspective you would like to add.

Option 2: Choose any latest research paper in services and explain your understanding and feedback on the same.

List of Experiments:

1. Design a new supermarket in a cosmopolitan city (Identify important attributes, specify attribute levels, experimental design, presentation of alternatives to respondents and estimation of choice model)
2. Choose any service organization and present it from the perspective of nature of service, classification of service, blueprint or service design analysis, and service quality.
3. Prepare a service blueprint for a fast-food outlet
4. Using data, software, user and mashup as services prepare a next gen service-oriented architecture.
5. Prepare a review article after analysing 5 relevant papers in services and explain your understanding and feedback on the same
6. Analyse a fortune 500 company in digital media and point out how these technologies could be effectively used in a start-up in digital space.
7. Analyse the booking policy of an international flight operator, assuming that the average number of no shows is 10%, explain why the best overbooking necessary isn't be 10% always.
8. Prepare a comparative chart analysing any four food delivery agencies and rank them based on reliability, responsiveness, assurance, and empathy.

19ECB432: IT PROJECT MANAGEMENT

L	T	P	C
3	0	2	4

This course enables learners to acquire knowledge on effective project management with focus on planning, scheduling, execution, and monitoring of information technology projects to enable delivery of projects within time and cost targets. Agile processes are introduced for project management. Familiarization with DevOps for continuous delivery and Containerization for deployment flexibility.

Course objectives:

- Understand project management overview
- Acquire knowledge of activities involved in projects management
- Learn Scrum method for Agile project management
- Illustrate planning and monitoring for sample projects
- Develop skills using DevOps for sample projects

UNIT I Projects Overview and Planning Number of hours (LTP) 9 6

IT Project Management overview: Nature of projects in IT – Product development projects, Services projects, Maintenance projects, Customization projects. Nature of project contracts- Cost plus, Time and Material, Fixed cost.

Project Management activities: Project Planning - Project Scope Identification, Feasibility analysis, Market and Demand Analysis, Software Pricing. Scope Management – Project Cost, resource, quality and time Estimation, Financial Appraisal. Project execution– Planning and scheduling project activities, Monitoring progress. Risk Management-Risk Analysis, planning, Monitoring. Quality Management, Configuration Management, Release planning, Change Control. Team work and Communication needs for project management, Project delivery and closure aspects.

Lab:

-Case studies for scope analysis, estimation, planning

-Setup an account with atlassian.net (Jira), explore Jira for project management teams (appreciation of following features- Issue / Task management, Roadmaps, Report & Analytics, Project backlogs, Project & issue customization, Granular user permissions, Workflow customization)

(Refer https://www.atlassian.com/software/jira/guides/use-cases/what-is-jira-used-for#jira-for-project-management-teams)

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand activities involved in project management (L1)
- distinguish different types of projects (L2)
- illustrate planning for simple projects (L3)
- analyse scope for sample projects (L4)
- create project management plan for team projects (L5)

UNIT II Project Planning and Scheduling Number of hours (LTP) 9 6

Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.

Cost Control and Scheduling: Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling Gantt Charts in project planning, Project Risk Analysis, Project monitoring and Control, Workflows, Work breakdown structure, Quality management - Issue management, Dependencies, Critical tasks; Project Communication- dashboards, Project Audit and Project Termination

Lab:

Explore Work breakdown structure, Gantt chart, dash boards in any open source tool like Jira

Create WBS for simple projects

Practice PERT, CPM on simple projects

Create WBS for team projects

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand planning with PERT, CPM (L1)
- distinguish different stages of Project Management (L2)
- demonstrate usage of PERT, CPM, Gantt charts for simple projects (L3)
- analyse dependencies for simple projects (L4)
- identify critical tasks, dependencies fro team projects (L5)

UNIT III Agile Project Management Number of hours (LTP) 9 6

Introduction, Agile Principles, Agile methodologies – Scrum, Lean, XP, FDD, DSDM, Crystal

Scrum Process- planning and monitoring in Scrum- Sprints, product backlog, sprint backlog, sprint review, retro perspective), Team members' roles and responsibilities in Scrum, Managing People, Best practices of Scrum.

Lab:

Team project planning and initiation of execution using Scrum process (using any open source tool like Jira)

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand Agile development concepts (L1)
- develop knowledge of different agile methods (L2)
- illustrate usage of scrum for simple projects (L3)
- analyse project requirements for sprints planning (L4)
- develop plan for team projects' implementation using scrum (L5)

UNIT IV DevOps Number of hours (LTP) 9 6

Project Development Operations' integrated View, DevOps stages and Components, Managing Source Code and Automating Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.

Lab:

Install Jenkins and explore various features of CD/CI pipeline

Use DevOps stages/components TTD, Configuration Management, Automated builds - for team projects

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand DevOps stages (L1)
- distinguish various operations in DevOps (L2)

- illustrate use of CI/CD for simple projects (L3)
- analyse DevOps requirements for simple projects (L4)
- develop plan for team project with CI/CD implementation using Jenkins's tool (L5)

UNIT V ITIL, Containers, case studies Number of hours (LTP) 9 6

Service Projects- IT Services Project Management processes- ITIL.

Containerization- deployment of applications using containers. Docker Engine, Virtual Machines vs. Containers. Challenges with Containers.

Case studies

Lab:

Deploy and run simple applications using containers (Kubernetes).

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand ITIL Processes (L1)
- distinguish traditional application deployment and containerization (L2)
- illustrate simple application deployment with containers (L3)
- analyse challenges with Containers (L4)
- develop deployment using containers for team project (L5)

Text Books:

1. Mike Cohn, Succeeding with Agile: Software Development Using Scrum, Addison Wesley, 2009
2. Pearson, Robert C. Martin, Juli, James Shore, The Art Of Agile Development, O'Reilly, 2013
3. John Hunt, Agile Software Construction, 1st Edition, Springer,2005
4. Somerville, Software Engineering, 10th edition (Chapter 3, Chapters 22 to 26), Pearson, 2017
5. Deepak Gaikwad, Viral Thakkar, DevOps Tools from Practitioner's Viewpoint, Wiley, 2019
6. James Turnbill, The Docker Book, 2019

Reference Books:

1. Roman Pichler, Agile Product Management with Scrum, Addison Wesley, 2011
2. Ken Schwaber, Agile Project Management with Scrum (Microsoft Professional), 2004
3. Andrew Stellman, Jenifer Greene, Head First Agile, Oreilly, 2017
4. Peggy Gregory, Casper Lassenius, Xiaofeng Wang Philippe Kruchten (Eds.), Agile Processes in Software Engineering and Extreme Programming, 22nd International Conference on Agile Software Development, XP 2021 Virtual Event, June 14–18, 2021, Proceedings, Springer
5. Joseph Phillips, IT Project Management: On Track from Start to Finish, 3rd Edition, McGraw-Hill, 2010
6. Clinton Keith, Agile Game Development, Addison Wesley, 2010
7. Scott M Graffius, Agile Scrum: Your Quick Start Guide with Step-by-Step Instructions, CreateSpace, 2016

Course Outcomes:

After completion of the course, the student will be able to:

- learn activities involved in IT projects management (L2)
- apply Agile process to project management (L3)
- plan application development using Scrum (L3)
- develop abilities to use DevOps in projects (L3)
- develop understanding of Containers use in projects (L2)

Lab Experiments:

Introduction of JIRA- Agile Project Management Tool

1. develop roadmap for the Epics and User Stories using JIRA
2. view and track Backlogs
3. manage sprints using JIRA
4. run the reports using JIRA

Introduction to Jenkins - Devops setup

1. Setup version control system like GIT and pull the code,
2. Setup Jenkins and Pull the code to Jenkins
3. Create Nodes using Jenkins and assign jobs to Nodes (Master as well to Slave)
4. Build using Maven, Unit Test using JUnit, execute Code coverage job, Code Quality using Jenkins, Package using Jenkins
5. Build pipeline and Deploy to the target server using Jenkins
6. Demonstrate Containerization using Docker and run Jenkins as Docker Image

Reference Links:
Reference Project Scope Management:
https://www.pm4dev.com/resources/free-e-books/7-project-scope-management/file.html
Team project planning and initiation of execution using Scrum process:
https:// www.atlassian.com/agile/tutorials/how-to-do-scrum-with-jira-software
Installing Jenkins and build pipeline:
DevOps Intro: https://www.youtube.com/watch?v=NJ7wmXLErQc
CI Intro: https://youtu.be/m1LuedXdcQc
GIT Setup: https://youtu.be/XenuDWIfb1c
JDK Installation: https://youtu.be/9xvEOCXI_nU
Jenkins Setup: https://youtu.be/WG8D1oOuiqE
Jenkins Node Creation: https://youtu.be/CzriLEEmHEQ
Jenkins Job Assignment: https://youtu.be/kzEmspUmk-E
Pre-Requisites Jenkins Build Pipeline: https://youtu.be/3AqtkAXnJ-Q
Unit Testing: https://youtu.be/hJ07Rhp3qbo
Creating Code coverage job: https://youtu.be/RuFkyJig7WM
Code Quality using Jenkins: https://youtu.be/CFz0Ar7lBcA
Packaging using Jenkins: https://youtu.be/3AqtkAXnJ-Q
Deployment: https://youtu.be/sq4v_IdIKS8
Build pipeline: https://youtu.be/ebGYJMvQYuo
Deploy and run simple applications using containers (Docker/Kubernetes):
https://www.docker.com/docker-desktop/getting-started-for-windows
https://kubernetes.io/docs/tutorials/_print/
PM Examples:
Case studies (General)
https://www.pmsolutions.com/case-studies
ITIL case studies
https://www.itilnews.com/index.php?categoryid=5&categorydescription=ITIL_and_ISO20000_Case_Studies
DevOps Case Studies
https://www.tcs.com/agile-transformation-ibm-mainframe-application-portfolios-2
Agile Methodology Examples and Case Studies
https://www.adaptovate.com/agile-examples-case-studies
Easy Project Management Tool case studies
https://www.easyproject.com/solutions/easy-project-management-case-studies

19EID402: MARKETING RESEARCH & MARKETING MANAGEMENT

L	T	P	C
2	0	0	2

Marketing as a subject primarily caters to the consumerist instincts of an individual. The markets are driven by consumer behaviour, which has evolved over time and is much more demanding these days. Consumer satisfaction takes primacy for a business to be successful. This calls for managers to adopt creative and unique marketing strategies to gain competitive advantage. Marketing Management equips managers with the required theoretical knowledge and practical skills to gain insights into the dynamic nature of the markets and then devise ways and means to effectively manage them.

Course objectives:

- To understand basic marketing and market research concepts.
- To comprehend the dynamic nature of marketing.
- To analyze how the various components of marketing interact with each other.
- To implement marketing concepts for effective management of resources for marketing.
- To evaluate basic concepts and application of statistical tools in Marketing research

UNIT I **Number of hours(LTP) 9**

Marketing Concepts and Applications: Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector.

Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social

Understanding the consumer: Determinants of consumer behavior, Factors influencing consumer behavior

Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning

Learning Outcomes:

After completion of this unit, the student will be able to:

- be familiar with the basic concepts of marketing (L2)
- appreciate the various elements of marketing mix and marketing environment (L2)
- comprehend the consumer behavior (L3)
- classify the different segments of the market (L4)
- assess the selection of target market and product positioning (L5)

UNIT II **Product Management** **Number of hours(LTP) 9**

Product Management: Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product decision and strategies, Branding & packaging

Learning Outcomes:

After completion of this unit, the student will be able to:

- be familiar with the basic concept of product life cycle (L2)

- appreciate the various steps of new product development process (L2)
- analyze the product decision strategies (L4)
- assess the concept of branding and packaging (L5)

UNIT III **Pricing, Promotion and Distribution Strategy** **Number of hours (LTP)** **9**

Policies & Practices – Pricing Methods & Price determination Policies. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M's of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising

Learning Outcomes:

After completion of this unit, the student will be able to:

- be familiar with the basic concepts of pricing methods (L2)
- appreciate the various price determination policies (L2)
- analyze the different components of marketing communication (L4)
- evaluate the concepts of marketing channels, retailing and advertising (L5)

UNIT IV **Marketing Research** **Number of hours (LTP)** **9**

Introduction, Type of Market Research, Scope, Objectives & Limitations

Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Qualitative Research

Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminant Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis

Learning Outcomes:

After completion of this unit, the student will be able to:

- be familiar with the basic concepts of Market research (L2)
- appreciate the various market research techniques (L2)
- analyze the different types of statistical tools (L4)
- evaluate the concepts of statistical hypothesis testing (L5)

UNIT V **Internet Marketing & Business-to-Business marketing** **Number of hours (LTP)** **9**

Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing. Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential. Product in business markets. Price in business markets. Place in business markets. Promotion in business markets. Relationship, networks and customer relationship management. Business to Business marketing strategy

Learning Outcomes:

After completion of this unit, the student will be able to:

- be familiar with the basic concepts of Internet marketing (L2)
- appreciate the various fundamental concepts of marketing like 7Ps (L2)
- analyze the difference in 4Ps of Business marketing (L4)
- evalauted the concepts of customer relationship management (L5)

Home Assignments:

1. Written Analyses of Cases – Students are expected to report on their analysis and recommendations of what to do in specific business situations by applying concepts and principles learned in class (Case Studies to be shared by Faculty) e.g. "Marketing Myopia"
2. Field visit & live project covering steps involved in formulating Market Research Project
3. Measuring Internet Marketing Effectiveness: Metrics and Website Analytics

Text Books:

1. Philip Kotler, Gary Armstrong and Prafulla Agnihotri, Principles of Marketing, Pearson India, 17th Edition. New Delhi: 2018
2. Rajan Saxena, Marketing Management, Tata-McGraw Hill, Fifth Edition New Delhi :2015
3. Malhotra, Naresh K. Marketing Research: An Applied Orientation. Upper Saddle River, NJ: Pearson/Prentice Hall, 2007. Print.

Reference Books:

1. C. B. Gupta and Dr. N. Rajan Nair, Marketing Management: Text and Cases 15th Edition, S. Chand and Sons 2012
2. N Rajan Nair and Sanjith R Nair, Marketing – Revised Edition, Sultan Chand & Sons – Tb, 2017
3. Indian Journal of Marketing
4. GITAM Journal of Management, GIM, GITAM University, Visakhapatnam
5. Vikalpa, IIM, Ahmedabad
6. Management Review, IIM, Bangalore

Course Outcomes:

After completion of the course, the student will be able to:

- understand basic marketing concepts (L2)
- comprehend the dynamics of marketing and analyze how its various components interact with each other in the real world (L4)
- leverage marketing concepts for effective decision making (L3)
- understand basic concepts and application of statistical tools in Marketing research (L2)

19EHS440: BEHAVIORAL ECONOMICS

L	T	P	C
3	0	2	4

This paper introduces the students the knowledge on current ideas and concepts regarding decision making in Economics particularly from behavioral science perspective, which can affect choices and behavior of firms, households, and other economic entities. An overview of important neoclassical and standard models applicable in both economics and psychology are blended to pave foundation in this emerging field.

Course objectives:

- To impart knowledge on contemporary ideas and concepts regarding decision making in Economics
- To understand and apply various concepts in traditional and modern Microeconomics
- To focus on decision making and develop a holistic understanding of the concepts in both economics and psychology
- To critically review the interconnections between the concepts
- To know the application and limitations of these models that affect choices

UNIT I Introduction Number of hours (LTP) 9 6

The neoclassical/ standard model and behavioral economics in contrast; historical background; behavioral economics and other social sciences; theory and evidence in the social sciences and in behavioral economics; applications – gains and losses, money illusion, charitable donation.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand neoclassical standard models of behavioral economics (L2)
- know historical background (L2)
- develop an understanding on theories and evidence in connection with social sciences (L3)
- grasp behavioral economics applications (L1)
- understand the uses of behavioral economics concepts in money illusions, gains and losses etc (L2)

UNIT II Basics Of Choice Theory Number of hours (LTP) 9 6

Revisiting the neoclassical model; utility in economics and psychology; models of rationality; connections with evolutionary biology and cognitive neuroscience; policy analysis – consumption and addiction, environmental protection, retail therapy; applications – pricing, valuation, public goods, choice anomalies.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand models of rationality (L2)
- understand connections with evolutionary biology and cognitive neuroscience (L2)
- see the clear picture of neoclassical models and utility in economics and psychology (L2)

- understand policy analysis in terms of consumption and addiction (L2)
- know environmental protection, retail therapy and applications like choice anomalies etc (L3)

UNIT III Beliefs, heuristics, biases and Choice under uncertainty **Number of hours (LTP) 9 6**

Revisiting rationality; causal aspects of irrationality; different kinds of biases and beliefs; self-evaluation and self-projection; inconsistent and biased beliefs; probability estimation; trading applications – trade in counterfeit goods, financial trading behavior, trade in memorabilia. Background and expected utility theory; prospect theory and other theories; reference points; loss aversion; marginal utility; decision and probability weighting; applications – ownership and trade, income and consumption, performance in sports.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the causal aspects of irrationality (L2)
- understand different kinds of biases and beliefs and know the aspects of self-evaluation (L2)
- understand inconsistent and biased beliefs and probability estimation trading applications (L2)
- understand expected utility theory and prospect theory; reference points and loss aversion (L2)
- analyse marginal utility; probability weighting and applications (L4)

UNIT IV Intertemporal Choice **Number of hours (LTP) 9 6**

Geometric discounting; preference over time; anomalies of inter-temporal decisions; hyperbolic discounting; instantaneous utility, alternative concepts – future projection, mental accounts, heterogenous selves, procedural choice, policy analysis – mobile calls, credit cards, organization of government; applications – consumption and savings, clubs and membership, consumption planning

Learning Outcomes:

After completion of this unit, the student will be able to:

- analyse the concepts of geometric discounting and preference over time (L4)
- understand and compare anomalies of inter-temporal decisions (L2)
- understand hyperbolic discounting and instantaneous utility (L2)
- evaluate alternative concepts like future projection, heterogenous selves etc. (L5)
- evaluate and justify the concepts of policy analysis and strategic choice (L5)

UNIT V Strategic Choice **Number of hours (LTP) 9 6**

Review of game theory and Nash equilibrium – strategies, information, equilibrium in pure and mixed strategies, iterated games, bargaining, signalling, learning; applications – competitive sports, bargaining and negotiation, monopoly and market entry. Individual preferences; Choice anomalies and inconsistencies; social preferences; altruism; fairness; reciprocity; trust; learning; communication; intention; demographic and cultural aspects; social norms; compliance and punishment; inequity aversion; policy analysis – norms and markets, labor markets, market clearing, public goods; applications – logic and knowledge, voluntary contribution, compensation design.

Learning Outcomes:

After completion of this unit, the student will be able to:

- analyse the concepts of game theory and Nash equilibrium (L4)
- understand and compare mixed strategies, iterated games, bargaining and signalling (L2)
- understand the applications in competitive sports, negotiation and monopoly (L2)
- evaluate individual and social preferences; choice anomalies and demographic / cultural aspects (L5)
- evaluate social norms; policy analysis and applications (L5)

Text Books:

1. N. Wilkinson and M. Klaes, An introduction to Behavioral Economics, Bloomsbury Publishing, 3rd edition, 2017.

Reference Books:

1. Tobias F. R., The Behavioral Economics of Inflation Expectations: Macroeconomics Meets Psychology, Cambridge University Press, 1st, 2020.

Course Outcomes:

After completion of the course, the student will be able to:

- gain an understanding on models in behavioral economics in relation with social sciences (L2)
- understand the basics of choice theories along with cognitive neurosciences (L2)
- demonstrate an understanding on beliefs, heuristics, biases and choices under uncertainty (L2)
- analyse intertemporal choices and the applications (L4)
- evaluate and analyse strategic choice, anomalies and its applications (L5)

19EID450: COMPUTATIONAL FINANCE AND MODELING

L	T	P	C
3	0	2	4

This course provides an introduction to mathematical models for financial markets and financial products. In particular, the course will focus on simulation and computational methods for modeling financial markets, pricing financial products, and finally optimizing financial portfolios.

Course objectives:

- Introduction to probability models for financial assets
- Computational tools for pricing of financial products
- Introduction to portfolio optimization

UNIT I Modeling of Financial Assets **Number of hours (LTP) 9 6**

No-Arbitrage Principle, One-Step Binomial Model, Risk, and Return, Forwards and Options, Risk-free assets, and risky assets

Learning Outcomes:

After completion of this unit, the student will be able to:

- calculate returns of basic risk-free assets (L3)
- calculate returns of risky assets (for different scenarios) (L3)
- simulate the tree models (L3)
- compute returns using tree models (L3)

UNIT II Discrete-time & Continuous-time Market Models **Number of hours (LTP) 9 6**

Stock and money market models, the principle of no-arbitrage, portfolio management, risk and expected returns of a portfolio

Learning Outcomes:

After completion of this unit, the student will be able to:

- simulate discrete-time market models (L3)
- simulate continuous-time market models (L3)
- compute risk and expected returns of a portfolio (L3)

UNIT III Forwards and Futures **Number of hours (LTP) 9 6**

Introduction to financial derivatives via forwards and futures

Learning Outcomes:

After completion of this unit, the student will be able to:

- price forwards and futures (L5)
- pricing of forwards and futures via simulation (L5)
- hedging using futures (L4)

UNIT IV Options and Option Pricing **Number of hours (LTP) 9 6**

European Call and put options, pricing of options, hedging of options

Learning Outcomes:

After completion of this unit, the student will be able to:

- call and put option pricing using binary models (L4)

- call and put option pricing using the Black-Scholes method (L4)

UNIT V Portfolio Management & Financial Engineering **Number of hours (LTP) 9 6**

Hedging of Portfolios, Value-at-risk

Learning Outcomes:

After completion of this unit, the student will be able to:

- towards portfolio optimization (L5)
- computing value-at-risk (L3)

Text Books:

1. *Mathematics of Finance: An Introduction to Financial Engineering*, M. Capinski and T. Zastawniak, Springer, 2010
2. *An Elementary Introduction to Mathematical Finance*, S. M. Ross, Cambridge University Press, 2011

Reference Books:

1. A First Course in Quantitative Finance, T. Mazzoni, Cambridge University Press, 2018
2. Simulation and Optimization in Finance, D. A. Pachamanova, Wiley & sons, 2010

Course Outcomes:

After completion of the course, the student will be able to:

- understand and simulate discrete-time models of financial assets (L3)
- understand and simulate continuous-time models of financial assets (L3)
- compute pricing of forwards, futures, and European options (L4)
- optimization of simple portfolios (L4)
- probabilistic simulations (L3)

19EID452: INDUSTRIAL PSYCHOLOGY

L	T	P	C
3	0	2	4

This course introduces students to the content areas of industrial psychology and the application of psychological theory to organizational issues. Topics include employment law, job analysis, recruitment and selection, training, performance appraisal and discipline, employee motivation, and workplace safety. Using an applied approach, this course will help prepare students for their roles as employees and managers.

Course objectives:

- To introduce learners on issues related to work, the factors that work behind in accomplishing the organizational objectives.
- To Understand the nuances of the recruitment, selection, and placement of employees and training needs
- To Understand the history and evolution of the subject and various aspects of job analysis
- To Understand the methods that are used for assessment of employees and appraisal systems
- To gain practical and application insights on employee's environments in which work related objectives are met with organizational goals

UNIT I Introduction Number of hours (LTP) 9

What is I/O Psychology? Research Methods, Statistics, and Evidence-based Practice, Introduction & Legal Context of Industrial Psychology, Job Analysis & Competency Modelling, Job Evaluation & Compensation, Job Design & Employee Well-Being, Recruitment

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the background of I/O psychology (L2)
- know the research methods and statistics applied (L2)
- develop an understanding on the legal context of Industrial psychology (L3)
- grasp knowledge on job analysis, job evaluation, job design and competency modelling (L2)
- understand the importance of employee well-being and the process of recruitment (L2)

UNIT II Assessments and Screening Methods Number of hours (LTP) 9

Identifying Criteria & Validating Tests and Measures, Screening Methods, Intensive Methods

Learning Outcomes:

After completion of this unit, the student will be able to:

- gain knowledge on assessments and identifying the criteria for testing tools (L2)
- understand the importance of standardized tests and validity of assessments (L2)
- know various screening methods (L2)
- understand intensive methods used in organizational context (L2)
- know different psychological assessments tools used in industrial context (L2)

UNIT III Performance Evaluation Number of hours (LTP) 9

Performance Goals and Feedback, Performance Coaching and Evaluation, Evaluating Employee Performance

Learning Outcomes:
After completion of this unit, the student will be able to:

- understand the importance of performance goals (L2)
- understand the role of performance appraisal and feedback systems (L2)
- gain knowledge on performance coaching and mentoring (L2)
- understand the role of employee evaluation and criteria used for evaluations (L2)
- analyse the importance of employee performance and outcomes (L4)

UNIT IV Employee Motivation Number of hours (LTP) 9
Employee Motivation, Satisfaction and Commitment, Fairness and Diversity
Learning Outcomes:
After completion of this unit, the student will be able to:

- grasp the importance of motivation in organizational context (L2)
- understand the role of job satisfaction in employee performance (L2)
- understand employee job commitment and factors that influence commitment (L2)
- evaluate the crucial aspects of fairness and equal job opportunities (L5)
- develop insights on work force diversity (L3)

UNIT V Leadership and Stress Management Number of hours (LTP) 9
Leadership, Organizational Climate, Culture, and Development, Teams in Organizations, the Organization of Work Behavior; Stress Management: Demands of Life and Work
Learning Outcomes:
After completion of this unit, the student will be able to:

- Develop insights on leadership and its role in organizational context (L3)
- Understand the importance of organisational climate and culture development (L2)
- Understand the applications and dynamics of teams in organizations (L2)
- Evaluate and analyse the organization work behaviours (L5)
- Gain understanding on the importance of stress management and work life demands (L2)

Text Books:

1. Landy, F. J. and Conte, J. M., Work in the 21st Century, Oxford Blackwell Publishing, 4th edition, 2013.

Reference Books:

1. Muchinsky, Paul M (2000).: Psychology Applied To Work, 6th edtion, Thomson Asia Pvt. Ltd
2. Miner, John B (1992): Industrial - Organizational Psychology, McGraw-Hill Inc.

Course Outcomes:
After completion of the course, the student will be able to:

- become conversant about the major content areas of Industrial Psychology (L3)
- gain further comfort with statistical concepts in the context of making personnel decisions to reinforce content learned in PSY203 or an equivalent introductory statistics course (L2)
- gain practical experience by completing a series of hands-on projects involving job analysis, selection decisions, training programs, and employee well-being (L3)
- deepen your understanding of tests and measurements so that you can collect accurate information and make sound data-based decisions (L5)
- prepare for other focused seminar courses in Industrial/Organizational Psychology or Human

Resource Management (L6)

19ECB450: ENTERPRISE SYSTEMS

L	T	P	C
3	0	2	4

Enterprise systems are large-scale application software packages that support business processes, information flows, reporting, and data analytics in complex organisations. This course is designed to give students a foundation of enterprise systems and explores the selection, design, implementation and management of enterprise IT solutions and their fit with the business. The focus is on Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM), Human Resource Management (HRM) and Business Analytics.

Course objectives:

- To understand the components of an ERP system.
- To know the implementation stages and processes of an ERP system.
- To understand the process of integrating legacy systems and other current IT systems with an ERP system.
- To understand the infrastructure of ERP systems.
- To understand and know the modern Enterprise Information Systems.

UNIT I **Number of hours (LTP) 9 6**

Introduction to Modern Enterprise Systems: Introduction to enterprise systems. Elements of enterprise systems – Business Information system, Decision support systems, Knowledge management systems, Financial and human resource systems. Kinds of Enterprise systems- B2C and B2B models.

Components of Enterprise systems: Channels (Mobile, web, desktop, partner integration), Data management, workflow, Controlling and Auditing, Accounting etc.

Sample Enterprise systems: ERP, SCM, CRM, Product Life cycle management (PLM), HR Systems (HRM), GL systems.

Learning Outcomes:

After completion of this unit, the student will be able to:

- familiarize the fundamentals of Modern Enterprise Systems (L2)
- analyse the components of Enterprise Systems (L4)
- understanding the Sample Enterprise Systems (L2)

UNIT II **Number of hours (LTP) 9 6**

Key characteristics Enterprise systems: Distributivity, Managed redundancy, Exception processing, Collaboration, Data transformation.

Enterprise System architectures: Batch processing, Monolithic, client server, ecommerce, service oriented, microservice, and cloud architectures.

Introduction to Enterprise Application architectures: Layer Architecture, Event driven Architecture, Service oriented Architecture, Microservice architecture, Plug-in architecture.

Learning Outcomes:

After completion of this unit, the student will be able to:

- illustrate the key characteristics of Enterprise systems (L3)
- summarizing the various Enterprise System Architectures (L2)
- summarizing the various Enterprise Application Architectures (L2)

UNIT III **Number of hours (LTP) 9 6**

Application architecture Patterns: Layering, Organizing domain logic, Mapping to database, Web Presentation, Concurrency

Enterprise Application Integration: Introduction to Enterprise Integration, different integration styles. Elements of messaging-based Integration.

Enterprise Integration patterns: Modern service integration techniques. Introduction to WSDL, SOAP. Introduction REST Ful webservices integration. Differences between SOAP and REST.

Learning Outcomes:

After completion of this unit, the student will be able to:

- describe the fundamentals of Application architecture patterns (L2)
- analyse the concepts of Enterprise Application Integration (L4)
- summarizing the various Enterprise Integration patterns (L2)

UNIT IV **Number of hours (LTP) 9 6**

Deployment of Enterprise applications: Key requirements in deployment - Stability, capacity, Security, availability, Network, Availability, and Transparency

Concepts of Cloud computing, cloud platforms and their role in Enterprise systems: Core Concepts – Types of Cloud: Private, public, and Hybrid clouds. Advantage of cloud computing – Scaling, Availability, and cost. Disadvantages – Technology overload, Security, Monitoring and troubleshooting, Testing, Latency etc. Cloud service models: - Infrastructure, platform, Software as a Service in Cloud Computing. Major public clouds: Google cloud, AWS, Azure.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the process of deployment of Enterprise applications (L2)
- explore the concepts of cloud computing and cloud platforms (L4)
- analyze the role of cloud platforms in Enterprise Systems (L4)

UNIT V **Number of hours (LTP) 9 6**

Application development and deployment in cloud–Dockers, micro services, Kubernetes, Serverless. Continuous Integration/Continuous Delivery

Introduction to Enterprise Architecture: Importance of Enterprise Architecture. Enterprise architecture models. Zachman Framework, TOGAF Framework

Enterprise Architecture Case study: To be identified

Learning Outcomes:

After completion of this unit, the student will be able to:

- describe the process of app development and deployment in cloud (L2)
- explaining the overview of importance of Enterprise Architecture (L2)
- summarize the various Enterprise Frameworks (L2)

Text Books:

1. Ralph Stair, George Reynold, "Principle of Information Systems", 10 ed.
2. Martin Fowler et al, "Pattern of Enterprise Application Architecture", Addison-Wesley, 2012
3. Gregor Hohpe, Bobby Woolf, Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions,
4. Mark Richards, Software Architecture patterns, 2015, O'Reilly.
5. Sam Newman, "Building Microservices", 2015, O'Reilly.
6. David Farley, Jez Humble, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", Jan 2016

Reference Books:

1. Brendan Burns, Designing Distributed Systems, O'Reilly, 2016
2. Enterprise Integration Patterns - Messaging Patterns Overview
3. Software architecture in Practice 3rd Edition- 2014

Course Outcomes:

After completion of this course, the student will be able to:

- understand basic elements of Enterprise systems (L2)
- develop skills in understanding architecture and non-functional requirements in developing enterprise system development and their deployment (L3)
- identify the factors that lead to the development and implementation of ERP systems (L3)
- analyse internal and external dimensions of enterprise systems by using an enterprise system (L4)
- understand future trends in Enterprise architectures (L2)

19EID456: ADVANCE FINANCE

L	T	P	C
3	0	2	4

The course will introduce learners to – various securities, their pricing and valuation. The course will provide knowledge on mergers and acquisitions, leases, financial restructuring and derivatives. This course covers strategic decisions involved in a business.

Course objectives:

- To provide understanding of essential terms, concepts and principles of strategic financial management
- To build the required skills and ability to apply principles of strategic financial management for corporate decision making
- To develop skills in students to use the techniques of planning and analysis

UNIT I Sources of Funds **Number of hours (LTP)** **12**

Sources of Funds (including regulatory framework): Types of securities - Issuing the capital in market - Pricing of issue - Valuation of Stocks and bonds

Evaluation of Lease Contracts: Leasing – Importance, Types, Tax Considerations, and Accounting Considerations – Evaluation of Lease from the point of view of Lessor and Lessee – Lease versus Buy Decision

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand lease contracts (L2)
- solve to arrive at decisions in case of lease contracts (L3)
- comprehend the various types of securities, pricing and valuation issues (L2)

UNIT II Dividend Decisions **Number of hours (LTP)** **9**

Dividend Decisions: Traditional Approach, Dividend Relevance Model, Miller and Modigliani Model, Stability of Dividends, Forms of Dividends, Issue of bonus shares, Stock Split

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the classification of dividend and their influence on EPS (L2)
- illustrate the use of MM Model for dividend decision (L3)

UNIT III Restructuring **Number of hours (LTP)** **12**

Corporate Restructuring: Mergers and Amalgamations – reasons for Merger, Benefits and Cost of Merger – Evaluation of Merger Proposal – Types of Mergers - Takeovers – Amalgamation - Leverage buy-out -Management buy-out -Corporate Failure and Liquidation. Financial Restructuring: Share Split –Consolidation -Cancellation of Paid-up Capital -Other Mechanisms

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand terminology related to mergers and acquisitions (L2)

- evaluate a merger proposal (L6)
- understand terminology related to Financial Restructuring (L2)
- comprehend the Need for financial restructuring (L2)

UNIT IV Working capital management **Number of hours (LTP) 12**

Working Capital Management: Working Capital Planning -Monitoring and Control of Working Capital -Working Capital Financing ¬Managing the Components of Working Capital-Cash Management -Receivable Management -Inventory Management

Learning Outcomes:

After completion of this unit, the student will be able to:

- prepare working capital requirements (L5)
- propose a credit policy using the accounts receivable information (L5)
- understanding the sources of financing working capital (L2)

UNIT V Derivatives **Number of hours (LTP) 15**

Introduction to derivatives: Basics of Futures, Forwards, Options, Swaps -Interest rate Payoff Diagrams, Pricing of Futures, Put Call Parity, Option Pricing using Binomial Model and Black Scholes Model -Use of Derivatives for Risk-Return Management- Credit Default Swaps

Learning Outcomes:

After completion of this unit, the student will be able to:

3. understand terminology related to Financial Restructuring (L2)
4. price American and European options (L3)
5. price forward and futures contracts (L3)
6. hedge underlying positions using derivatives (L4)

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.

Further, the topic for class discussion will be mentioned beforehand and students should be prepared to discuss these topics in class. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Historical perspectives of markets like major boom and busts, bull and bear cycles, major market crashes, bubbles
2. Topic: Major scams in the market, e.g. Satyam case

Text Books:

1. Brealey, Myers and Allen, Principles of Corporate Finance, Tat Mc.Graw Hill.

Reference Books: All latest available editions

1. Jonathan Berk, Peter DeMarzo, and Ashok Thampi, Financial Management, Pearson Education in South Asia,
2. Damodaran, Corporate Finance Theory and Practice, John Wiley & Sons
3. Rajiv Srivastava and Anil Misra, Financial Management, Oxford University Press
4. James C Van Horne, and John M. Wachowicz, Fundamentals of Financial Management, PHI
5. Kevin K. Boeh and Paul W. Beamish, Mergers and Acquisitions: Text and Cases, Sage Publications

6. John C Hull, Fundamentals of Futures and Options Markets, Cambridge University Press

Websites:
1. https://ocw.mit.edu/courses/sloan-school-of-management

Course Outcomes:
After completion of the course, the student will be able to:

- imbibe knowledge about the decisions and decision variables involved with financial activities of the firm (L3)
- develop skills for interpretation business information and application of financial theory in corporate investment decisions, with special emphasis on working capital management (L3)
- familiarizing the students with the corporate and financial restructuring (L2)

19ECB452: IMAGE PROCESSING AND PATTERN RECOGNITION

L	T	P	C
3	0	2	4

Image processing becomes a very important aspect in various industries ranging from process industry to medical field. This course will help to understand the fundamentals of image processing. The course consists of theoretical material introducing the mathematics of images and imaging. Student will also learn to apply various processes on images for image understanding. Topics include representation of two-dimensional data, time and frequency domain representations, filtering and enhancement, the Fourier transform, convolution, interpolation. The student will become familiar with Image Enhancement, Image Restoration, Image Compression, Morphological Image Processing, Image Segmentation, Representation and Description, and Object Recognition. The course also touches the design aspects and realization of image processing applications. This course covers the investigation, creation, and manipulation of digital images by computer.

Course objectives:

- To develop a theoretical foundation of Digital Image Processing concepts.
- To provide mathematical foundations for digital manipulation of images; image acquisition; pre-processing; segmentation; Fourier domain processing; and compression.
- To gain experience and practical techniques to write programs for digital manipulation of images; image acquisition; pre-processing; segmentation; Fourier domain processing; and compression.

UNIT I Introduction Number of hours (LTP) 6 0 4

Introduction: Image processing systems and its applications. Basic image file formats
Image formation: Geometric and photometric models; Digitization - sampling, quantization; Image definition and its representation, neighbourhood metrics.

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the basics of image processing (L2)
- create an image (L3)

UNIT II Intensity transformations and spatial filtering Number of hours (LTP) 6 0 4

Intensity transformations and spatial filtering: Enhancement, contrast stretching, histogram specification, local contrast enhancement; Smoothing, linear and order statistic filtering, sharpening, spatial convolution, Gaussian smoothing, Derivatives of Gradients, Laplacian of Gradients.

Learning Outcomes:

After completion of this unit, the student will be able to:

- do various intensity transformations (L3)
- do different filtering techniques (L3)

UNIT III Segmentation Number of hours (LTP) 6 0 4

Segmentation: Pixel classification; Grey level thresholding, global/local thresholding;

Optimum thresholding - Bayes analysis, Otsu method; Derivative based edge detection operators, edge detection/linking, Canny edge detector; Region growing, split/merge techniques, line detection, Hough transform.

Learning Outcomes:
After completion of this unit, the student will be able to:

- implement pixel classification techniques (L3)
- extract the edges of objects (L3)

UNIT IV Image/Object features extraction Number of hours (LTP) 6 0 4

Image/Object features extraction: Textural features - gray level co-occurrence matrix; Moments; Connected component analysis; Convex hull; Distance transform, medial axis transform, skeletonization/thinning, shape properties.

Learning Outcomes:
After completion of this unit, the student will be able to:

- learn about the features in an image (L2)
- extract the features (L3)

UNIT V Registration and Processing Number of hours (LTP) 6 0 4

Registration: Mono-modal/multimodal image registration; Global/local registration; Transform and similarity measures for registration; Intensity/pixel interpolation.

Colour image processing: Fundamentals of different colour models - RGB, CMY, HSI, YCbCr, Lab; False colour; Pseudo colour; Enhancement; Segmentation.

Morphological Filtering Basics: Dilation and Erosion Operators, Top Hat Filters

Learning Outcomes:
After completion of this unit, the student will be able to:

- register the images (L3)
- implement various image processing techniques (L3)

Text Books:

1. Gonzalez & Woods, ―Digital Image Processing‖, 3rd ed., Pearson education, 2008
2. Jain Anil K., ―Fundamentals Digital Image Processing‖, Prentice Hall India, 2010

Reference Books:

1. Milan Sonka, Vaclav Hlavav, Roger Boyle, ―Image Processing, Analysis and Machine Vision‖, 2nd ed., Thomson Learning, 2001
2. Rangaraj M. Rangayyan, ―Biomedical Image Analysis‖, CRC Press, 2005
3. Pratt W.K, ―Digital Image Processing‖, 3rd ed., John Wiley & Sons, 2007
4. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education

Course Outcomes:
After completion of the course, the student will be able to:

- apply knowledge of mathematics for image understanding and analysis (L3)
- design and analysis of techniques / processes for image understanding (L4)
- design, realize and troubleshoot various algorithms for image processing case studies (L4)
- select the appropriate hardware and software tools (Contemporary) for image analysis (L5)

Lab Experiments:

1. Write a program for image enhancement considering order-statistics filter, Gaussian smoothing, Difference of Gaus sian and Laplace of Gaussian Filters.
2. Write a program for histogram specification of an given image considering:
   a) Rayleigh distribution
   b) Gamma Distribution
   c) log Normal distribution.
3. Compare the obtained result.
4. Write a program to implement the ostu thresholding algorithms for image thresholding
5. write a program to implement the sobel and canny edge detection algorithm
6. Write a program to compute the gray level co-occurrence matrix and in turn compute the texture features like homogeniety, entropy, contrast and energy. Use obtain feature for pixel classification using any standard classifier.
7. write a program for implementing the skeletonization/thinning of binary image.
8. write a program for registration of image considering linear transformation.
9. Implement the cubic interpolation for upsampling a given image.
10. write a program to transform a RGB color image to HSI and YcbCr color image. Perform segmentation using Ostu's thresholding on the three types of the color images.
11. Write a program to show a dilation and erosion on a given binary image.
12. Write a program for erosion and dilation, opening & closing using inbuilt and without inbuilt function.
13. Implement various noise models and their Histogram
14. Implement Image compression using DCT Transform

19ECB491: PROJECT EVALIUATION II

L	T	P	C
0	0	2	1

Project is a short project intended to train students to identify a problem
of practical significance and are expected to continue with their work of Project Evaluation I of Semester VII and accomplish the following activities:
i) Implementation: Coding, Testing
ii) Results and Discussion
iii) Conclusion and Future Scope
iv) References
and submit a report.
The project can be an individual or maximum of four persons.