SEM IV: TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
CEC401	Applications of Mathematics in Engineering-II	3 – 0 – 1	04	3 – 0 – 1	04	BS
CEC402	Analysis of Algorithms	3 – 0 – 0	03	3 – 0 – 0	03	PC
CEC403	Operating System	3 – 0 – 0	03	3 – 0 – 0	03	PC
CEC404	Theory of Computer Science	3 – 0 – 0	03	3 – 0 – 0	03	PC
CEC405	Multidisciplinary Minor Course	3 – 0 – 0	03	3 – 0 – 0	03	MM
CEL402	Analysis of Algorithms Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
CEL403	Operating System Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
CEL404	Multidisciplinary Minor Lab.	0 – 2 – 0	02	0 – 1 – 0	01	MM
CEPR42	Community Engagement PBL – Mini Project II	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
CEXS48	Skill Enhancement – SAT VIII: Skill-Based Learning: Python Programming	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
CEXA49	Ability Enhancement – SAT IX: Skill-Based Learning: Indian/Foreign Modern language	0 – 2[*] – 0	02	0 – 1 – 0	01	AE-SAT
Total		**15 – 12 – 1**	**28**	**15 – 6 – 1**	**22**	

[*]SAT can be conducted as TH or P or both as required.

[$]Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
CEC401	Applications of Mathematics in Engineering-II	20	20	40	60	2.5	25	-	-	-	125
CEC402	Analysis of Algorithms	20	20	40	60	2.5	-	-	-	-	100
CEC403	Operating System	20	20	40	60	2.5	-	-	-	-	100
CEC404	Theory of Computer Science	20	20	40	60	2.5	-	-	-	-	100
CEC405	Multidisciplinary Minor Course	-	-	-	-	-	50	50	-	-	100
CEL402	Analysis of Algorithms Lab	-	-	-	-	-	25	-	-	25	50
CEL403	Operating System Lab	-	-	-	-	-	25	-	25	-	50
CEL404	Multidisciplinary Minor Lab.	-	-	-	-	-	25	-	-	-	25
CEPR42	Community Engagement PBL – Mini Project II	-	-	-	-	-	25	-	-	25	50
CEXS48	Skill Enhancement – SAT VIII: Skill-Based Learning: Python Programming	-	-	-	-	-	25	-	-	-	25
CEXA49	Ability Enhancement – SAT IX: Skill-Based Learning: Indian/Foreign Modern language	-	-	-	-	-	25	-	-	-	25
Total		**80**	**80**	**160**	**240**	-	**225**	**50**	**25**	**50**	**750**

Course Code	Course Name	Credits Assigned			
		TH	P	TUT	Total
CEC401	Applications of Mathematics in Engineering-II	03	-	01	04

Prerequisites:	1. Engineering Mathematics-I 2. Engineering Mathematics-II 3. Applications of Mathematics in Engineering-I
Course Objectives (COBs):	1. Matrix algebra to understand engineering problems. 2. Line and Contour integrals and expansion of a complex valued function in a power series. 3. To understand the concepts of vector spaces used in the field of machine learning and engineering problems. 4. The concepts of probability distributions and sampling theory for small samples. 5. Linear and Non-linear programming problems of optimization.
Course Outcomes (COs):	**Upon completion of the course, the learners will be able to:** 1. Determine eigenvalues, eigenvectors of matrices and study diagonalization. 2. Find nullity of the matrix as well as the factorization of the matrix. 3. Find the estimate of location, variability, covariance and correlation. 4. Evaluate probability distribution. 5. Use sampling theory in decision making problems. 6. Solve optimization problems using techniques of Linear and Non-Linear Programming.

Module No. & Name	Sub-Topics	CO Mapped	Hrs / Sub Topics	Total Hrs/ module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Linear Algebra (Theory of Matrices)	Characteristic Equation, Eigenvalues and Eigenvectors, and Properties (without proof).	CO1	02	06
	Cayley-Hamilton Theorem (without proof-state and verify), Verification and Reduction of Higher Degree Polynomials.		02	
	Similarity of Matrices, Diagonalizable and Non-Diagonalizable Matrices.		02	

2. Linear Algebra: Theory of Matrices II	(Recall: Trace, determinant of matrices, Rank of the matrix), Nullity of the matrices (upto 4×4 matrices)	**CO2**	**02**	**07**
	Matrix factorization : LU factorization- Cholesky factorization		**02**	
	Singular Value Decomposition		**03**	
3. Statistics for Data Analysis	Estimates of locations (Mean, Median, Mode, Quartiles (Q1, Q2, Q3))	**CO3**	**02**	**06**
	Estimates of variability (Range, Inter quartile range, standard deviation, variance)		**02**	
	Covariance and Correlations (Kendall rank correlation).		**02**	
4. Probability Distribution	Discrete Probability Distribution: Binomial distribution, Poisson distribution	**CO4**	**02**	**07**
	Continuous Probability Distribution: Normal Distribution, Exponential distributions, Webill distribution		**05**	
5. Sample Testing	Sampling Distribution, Test of Hypothesis, Level of Significance, Critical Region, One-tailed, and Two-tailed Test, Degree of Freedom.	**CO5**	**02**	**07**
	Students' t-distribution (Small Sample), Test Significance of Mean and Difference between the Means of Two Samples, Chi-Square Test: Test of Goodness of Fit and Independence of Attributes, Contingency Table.		**03**	
	ANOVA test		**02**	
6.Linear & Non Linear Programming Problems	Types of Solutions, Standard and Canonical of LPP, Basic and Feasible solutions, Slack Variables, Surplus Variables, Simplex Method.	**CO6**	**03**	**06**
	Unconstrained & constrained NLPP using Method of Lagrange's Multiplier (with one-equality constraint with two and three variables)		**03**	
ii.Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	**-**	**01**	**01**
Total Hours				**42**
Text Books:	1. E. Kreyszig, Advanced Engineering Mathematics, Wiley. 2. R. Jain and S. Iyengar, Advanced Engineering Mathematics, Narosa Publication. 3. J. Brown and R. Churchill, Complex Variables and Applications, McGraw Hill.			

<table>
<tr><td>Reference Books:</td><td>1. T. Veerarajan, Probability, Statistics and Random Processes, McGraw Hill.
2. H. Taha, Operations Research: An Introduction, Pearson.
3. S. Rao, Engineering Optimization: Theory and Practice, Wiley.
4. D. Hira and P. Gupta, Operations Research, S. Chand and Sons.
5. B. L. Agarwal, Basic Statistics, New Age International publishers.
6. H. K. Dass, Advance Engineering Mathematics, S. Chand and Company ltd</td></tr>
<tr><td>Useful Links:</td><td>1. https://nptel.ac.in/courses/111/108/111108066/
2. https://nptel.ac.in/courses/111/103/111103070/
3. https://nptel.ac.in/courses/111/104/111104071/
4. https://nptel.ac.in/courses/111/105/111105041/
5. https://www.coursera.org/learn/complex-analysis
6. NPTEL :: Biotechnology - NOC:Data Analysis for Biologists
7. https://nptel.ac.in/courses/111101165
8. https://nptel.ac.in/courses/104106121</td></tr>
<tr><td>Term Work (TW):</td><td>1. Term work should consist of 6 batch wise tutorials.
2. Journal must include at least 2 assignments on content of theory of the course.
The distribution of term work marks will be as follows
<table>
<tr><td>1</td><td>Tutorials</td><td>20</td></tr>
<tr><td>2</td><td>Assignment</td><td>05</td></tr>
</table></td></tr>
<tr><td colspan="2">Assessment:</td></tr>
<tr><td colspan="2">Continuous Assessment for 40 marks:
1. Test 1 – 20 marks
2. Test 2 – 20 marks</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60 marks for 02 hrs 30 min duration</td></tr>
</table>

Course Code	Course Name	Credits (TH+P+TUT)
CEC402	Analysis of Algorithms	3 - 0 - 0

Prerequisite:	1. Data structure concepts 2. Discrete structures
Course Objectives:	1. To provide mathematical approaches for Analysis of Algorithms 2. To understand and solve problems using various algorithmic approaches 3. To analyze algorithms using various methods
Course Outcomes:	**At the end of the course, the students should be able to..** 1. Analyze the running time and space complexity of algorithms 2. Describe, apply and analyze the complexity of divide and conquer strategy. 3. Describe, apply and analyze the complexity of greedy strategy. 4. Describe, apply and analyze the complexity of dynamic programming strategy. 5. Explain and apply backtracking, branch and bound. 6. Explain and apply string matching techniques.

Module No. & Name	Sub-Topics	CO mapped	Hrs / Sub Topics	Total Hrs/Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	**-**	**01**	**01**
1.Introduction	Performance analysis, space and time complexity, Growth of function, Big- Oh, Omega Theta notation. Mathematical background for algorithm analysis.	**CO1**	**03**	**09**
	Complexity class: Definition of P, NP, NP-Hard, NP-Complete		**01**	
	Analysis of selection sort, insertion sort		**02**	
	Recurrences: The substitution method, Recursion tree method, Master method		**03**	
2. Divide and Conquer Approach	General method, Merge sort, Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	**CO2**	**05**	**05**
3. Greedy Method Approach	General Method, Single source shortest path: Dijkstra Algorithm Fractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms	**CO3**	**06**	**06**
4. Dynamic Programming Approach	General Method, Multistage graphs, Single source shortest path: Bellman Ford Algorithm All pair shortest path: Floyd Warshall Algorithm	**CO4**	**05**	**10**

	Assembly-line scheduling Problem, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence		**05**	
5. Backtracking and Branch and bound	General Method, Backtracking: N-queen problem, Sum of subsets, Graph coloring	**CO5**	**03**	**06**
	Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem		**03**	
6. String Matching Algorithms	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	**CO6**	**04**	**04**
ii. Course Conclusion	Recap of Modules, Outcomes, Application and Summarization.	**-**	**01**	**01**
Total Hours				**42**

Books:

Text Books	1. T. H. Cormen, C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005. 2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.
Reference Books	1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition. **2.** S. K. Basu, "Design Methods and Analysis of Algorithm", PHI**.**

Useful Links:

1. https://nptel.ac.in/courses/106/106/106106131/
2. https://swayam.gov.in/nd1_noc19_cs47/preview
3. https://www.coursera.org/specializations/algorithms
4. https://www.mooc-list.com/tags/algorithms

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 20 marks
2. Test 2 – 20 marks

End Semester Theory Examination will be of 60 marks for 02 hrs 30 min duration

Course Code	Course Name	Credits (TH+P+TUT)
CEC403	Operating Systems	3-0-0

Prerequisite:	1. Data structures 2. Computer architecture
Course Objectives:	1. To introduce basic concepts and functions of operating systems. 2. To understand the concept of process, thread and resource management. 3. To understand the concepts of process synchronization and deadlock. 4. To understand various Memory, I/O and File management techniques.
Course Outcomes:	**After the successful completion of this course, learner will be able to:** 1. Describe the objectives, functions and structure of OS 2. Analyze the concept of process management and evaluate performance of process scheduling algorithms. 3. Apply the concepts of synchronization and deadlocks 4. Evaluate performance of Memory allocation and replacement policies 5. Explain the concepts of file management. 6. Apply concepts of I/O management and analyze techniques of disk scheduling.

Module No & Name	Sub-Topics	CO mapped	Hrs /Sub Topics	Total Hrs/ Module
i. Prerequisite	Prerequisites concepts and course introduction	--	**01**	**01**
1. Operating system Overview	Introduction, Objectives, Functions and Evolution of Operating System	**CO1**	**02**	**05**
	Operating system structures: Layered, Monolithic and Microkernel		**01**	
	Linux Kernel, Shell and Shell Programming, System Calls		**02**	
2. Process and Process Scheduling	Concept of a Process, Process States, Process Description, Process Control Block.	**CO2**	**02**	**09**
	Uniprocessor Scheduling-Types: Preemptiveand Non-preemptive , scheduling algorithms (FCFS, SJF, SRTN, Priority, RR)		**04**	
	Threads: Definition and Types, Concept of Multithreading		**03**	
3. Process Synchronizat - ion and Deadlocks	Concurrency: Principles of Concurrency,Inter- Process Communication, Process Synchronization	**CO3**	**02**	**09**
	Mutual Exclusion: Requirements Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem		**03**	

	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm		**02**	
	Deadlock Detection and Recovery, Dining Philosophers Problem		**02**	
4. Memory Management	Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning	**CO4**	**02**	**09**
	Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit		**02**	
	Paging and Segmentation, TLB		**02**	
	Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU, Thrashing		**03**	
5. File Management	Overview, File Organization and Access	**CO5**	**02**	**04**
	File Directories		**01**	
	File Sharing		**01**	
6. IO Management	I/O devices, Organization of the I/O Function, Disk Organization	**CO6**	**01**	**04**
	I/O management		**01**	
	Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK		**02**	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	**--**	**01**	**01**
Total Hours				**42**

Books:

Text Books	**1.** William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014, ISBN-10: 0133805913, ISBN-13: 9780133805918. 2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9th Edition, 2016, ISBN 978-81-265-5427-0
Reference Books	1. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition. 2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rd Edition 3. Maurice J. Bach, "Design of UNIX Operating System", PHI 4. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4th Edition

Useful Links:

1. https://swayam.gov.in/nd1_noc19_cs50/preview

2. https://nptel.ac.in/courses/117/106/117106113/

3. https://nptel.ac.in/courses/117/106/117106113/

4. https:/www.classcentral.com/course/swayam-introduction-to-operating-systems-6559

5. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/CRUX/labs/exp1/theory.html

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 20 marks
2. Test 2 – 20 marks

End Semester Theory Examination will be of 60 marks for 02 hrs 30 min duration.

Course Code	Course Name	Credits (TH+P+TUT)
CEC404	**Theory of Computer Science**	**3- 0 – 0**
Prerequisite:	Discrete Structure	
Course Objectives:	1. Acquire conceptual understanding of fundamentals of grammars and languages. 2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata. 3. Develop understanding of different types of Turing machines and applications. 4. To develop the knowledge and skills necessary to apply these models to solve real world problems.	
Course Outcomes:	**After the successful completion of this course, learner will be able to:** 1. Describe concepts of Theoretical Computer Science, difference and equivalence of DFA and NFA. 2. Discuss key notions of regular expression and pumping lemma for regular language. 3. Design Context free and regular grammar to recognize the language. 4. Solve problems on push down Automata. 5. Develop an understanding of computation through Turing Machine. 6. Acquire fundamental understanding of decidability and undecidability.	

Module No. & Name	Sub Topics	CO mapped	Hrs / Sub Topics	Total Hrs/ Module
i. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	**-**	**01**	**01**
1. Basic Concepts of a Finite Automata	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM).	**CO1**	**03**	**09**
	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε- transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.		**06**	
2. Regular Expressions and Languages	Regular Expression (RE), Equivalence of RE and FA, Arden's Theorem, RE Applications	**CO2**	**03**	**07**
	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs		**04**	
3. Grammar	Grammars and Chomsky hierarchy	**CO3**	**02**	**08**
	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA		**03**	
	Context Free Grammars (CFG) Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.		**03**	

4. Pushdown Automata (PDA)	Definition, Language of PDA, PDA as generator, decider and acceptor of CFG.	**CO4**	**02**	**04**
	Deterministic PDA, Non- Deterministic PDA, Application of PDA.		**02**	
5. Turing Machine (TM)	Definition, Design of TM as generator, decider and acceptor	**CO5**	**04**	**09**
	Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.		**05**	
6. Undecidability	Decidability and Undecidability, Recursive and Recursively Enumerable Languages.	**CO6**	**01**	**03**
	Halting Problem, Rice's Theorem, Post Correspondence Problem		**02**	
ii. Course conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	**--**	**01**	**01**
Total Hours				**42**

Books:

Text Books	1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages and Computation", 3rd Edition, Pearson Education, 2008. 2. Michael Sipser, "Theory of Computation", 3rd Edition, Cengage learning. 2013. 3. Vivek Kulkarni, "Theory of Computation", Illustrated Edition, Oxford University Press, (12 April 2013) India
Reference Books	1. J. C. Martin, "Introduction to Languages and the Theory of Computation", 4 th Edition, Tata McGraw Hill Publication. 2. Kavi Mahesh, "Theory of Computation: A Problem Solving Approach", Kindle Edition, Wiley-India, 2011.

Useful Links:

1. www.jflap.org
2. https://nptel.ac.in/courses/106/104/106104028/
3. https://nptel.ac.in/courses/106/104/106104148/

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 20 marks
2. Test 2 – 20 marks

End Semester Theory Examination will be of 60-Marks for 02 hrs 30 min duration.

Course Code	Course Name	Credits (TH+P+TUT)
CEC405	**Connecting IoT Gateway using AWS Services**	**3-0-0**

Prerequisite:	Science and Maths till 12th STD or Diploma in Engineering and Fundamentals from earlier semester.
Course Objectives:	The course aims to equip students with a comprehensive understanding of IoT architecture, focusing on the integration of microcontrollers and gateways, communication protocols, cloud services using AWS, and practical applications in various industries.
Course Outcomes:	Upon completion of this course, students will be able to: 1. Design and implement IoT solutions using microcontrollers and gateways. 2. Analyze and apply various IoT communication protocols. 3. Utilize AWS cloud services for IoT data storage, processing, and analytics. 4. Develop and deploy practical IoT applications across different sectors.

Module Number & Name	Sub Topics	CO mapped	Hrs / Sub topics	Total Hrs / Module
1. IoT Gateway and Microcontrollers	Know Your IoT Gateway		**12**	**19**
	Microcontrollers - Arduino		**7**	
2. IoT Communication Protocols	IoT Communication Protocols		**5**	**05**
	Video Resources (Self - Study)		**NA**	
3. IoT Services and Cloud Computing using AWS	Unlocking Power of IoT using AWS		**5**	**25**
	Mobile Browser to IoT Gateway Communication		**5**	
	Cloud Connectivity For IoT Applications		**5**	
	How to Open AWS Account		**5**	
	AWS Cost Management		**5**	
4. Applications	Home Security Solution- Digital Lock			**10**
Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.		**1**	**01**
			Total Hours	**60**
TW: 50 Marks **Oral : 50 Marks**				

Lab Code	Lab Name	Credits (P+TUT)
CEL402	**Analysis of Algorithms Lab**	**0-1-0**

Prerequisite:	Basic knowledge of programming and data structure
Lab Objectives:	1. To introduce the methods of designing and analyzing algorithms 2. Design and implement efficient algorithms for a specified application 3. Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem. 4. Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.
Lab Outcomes (LOs):	**At the end of the course, the student will be able to** 1. Implement the algorithms using different approaches 2. Analyze the complexities of various algorithms 3. Compare the complexity of the algorithms for specific problems 4. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO mapped	Hrs/Lab
0	Lab Prerequisites	**-**	**02**
1	**Introduction:(Implement any 2)** Selection sort, Insertion sort	**LO1, LO2, LO3, LO4**	**04**
2	**Divide and Conquer Approach :(Implement any 2)** Finding Minimum and Maximum, Merge sort, Quick sort, Binary search	**LO1, LO2, LO3, LO4**	**04**
3	**Greedy Method Approach :(Implement any 2)** Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm	**LO1, LO3, LO4**	**04**
4	**Dynamic Programming Approach:(Implement any 2)** Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall , 0/1 knapsack, Travelling salesperson problem Longest common subsequence	**LO1, LO4**	**04**
5	**Backtracking and Branch and bound:(Implement any 2)** N-queen problem Sum of subsets Graph coloring	**LO1, LO4**	**04**
6	**String Matching Algorithms:(Implement any 2)** The Naïve string-matching Algorithms The Rabin Karp algorithmThe Knuth-Morris-Pratt algorithm	**LO1, LO4**	**06**

Text Books	1. T. H. Cormen, C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005. 2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.
Reference Books	1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition. **2.** S. K. Basu, "Design Methods and Analysis of Algorithm", PHI**.**

Useful Links:

1. https://nptel.ac.in/courses/106/106/106106131/
2. https://swayam.gov.in/nd1_noc19_cs47/preview
3. https://www.coursera.org/specializations/algorithms
4. https://www.mooc-list.com/tags/algorithms

Term work:

1. Term work should consist of at least 10 experiments
2. Journal must include at least 2 assignments on content of theory and practical of the course "Analysis of Algorithms"
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 20-marks, Assignments: 05-marks)

Oral & Practical Exam:

Oral & practical examination will be based on entire syllabus of CEC402 and CEL402

Lab Code	Lab Name	Credits (P+TUT)
CEL403	**Operating Systems Lab**	**0-1-0**

Prerequisite:	1. Computer Organization 2. Data Structures and Algorithms
Lab Objectives:	1. To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment. 2. To familiarize students with the architecture of Linux OS. 3. To provide necessary skills for developing and debugging programs in Linux environment. 4. To learn programmatically to implement simple operation system mechanisms
Lab Outcomes (LOs):	**At the end of the course, the student will be able to:** 1. Demonstrate basic Operating system Commands, Shell scripts, System Calls and API with respect to Linux 2. Implement various process scheduling algorithms and evaluate their performance. 3. Implement and analyze concepts of synchronization and deadlocks. 4. Implement various Memory Management techniques and evaluate their performance. 5. Implement and analyze concepts of virtual memory, concepts of file management and I/O management techniques. 6. Apply ethical principles like timeliness and adhere to rules of laboratory.

Lab No.	Experiment Title	LO mapped	Hrs/ Lab
0	Prerequisite	**-**	**02**
1	**<u>Explore Linux Commands</u>** **Explore usage of basic Linux Commands and system calls for file, directory and process management.** Commands: mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. System Calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.	**LO1, LO6**	**02**
2	**<u>Linux shell script</u>** Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. e. Display current shell, home directory, operating system type, current path setting, current working directory	**LO1, LO6**	**02**

3	**<u>Linux- API</u>** Implement any one basic commands of Linux like ls, cp, mv and others using kernel APIs.	**LO1, LO6**	**02**
4	**<u>Linux- Process</u>** a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. b. Explore wait and waitpid before termination of process.	**LO2, LO6**	**02**
5	**Process Management: Scheduling** a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms	**LO2, LO6**	**02**
6	**Process Management: Synchronization** a. Write a C program to implement solution of Producer consumer problem through Semaphore b. Write a C program to implement solution of Reader's Writer's problem through Semaphore	**LO3, LO6**	**02**
7	**<u>Process Management: Deadlock</u>** a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm b. Write a program demonstrate the concept of Dining Philosopher's Problem c. Simulate deadlock detection using CPU-OS Simulator	**LO3, LO6**	**02**
8	**<u>Memory Management</u>** a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e., Best Fit, First Fit, Worst- Fit etc.	**LO4, LO6**	**02**
9	**<u>Memory Management: Virtual Memory</u>** a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.	**LO5, LO6**	**02**
10	**<u>File Management & I/O Management</u>** a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. c. Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN	**LO5, LO6**	**02**
Virtual Lab Links:			
1. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/CRUX/labs/exp1/theory.html			

Term work:

1. Term work should consist of a minimum of 10 experiments covering all modules.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Operating Systems"
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 20-marks, Assignments: 05-marks)

Practical & Oral Exam:

Practical Exam will be conducted based on the entire syllabus of CEC403 and CEL403

Course code	Course Name	Credits
CEPR42	**Community Engagement Project / Field Project –Mini Project-II**	**0-2-0**

Objectives:	1. To acquaint yourself with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.
Outcome:	**After successful completion of this course learner will be able to…** 1. Identify problems based on societal /research needs. 2. Design solutions or system components or processes that meet the specified needs 3. Select appropriate tools to implement the project. 4. Develop interpersonal skills to work as a member of a group or leader 5. Excel in written and oral communication. 6. Demonstrate project management principles during project work. 7. Demonstrate capabilities of investigation and self-learning by oneself or as a team gaining life skills

Guidelines for Mini Project

1	Project based learning Mini Project Lab-1 should be implemented preferably using Python programming (CEXS45)
2	Students shall form a group of 2 to 3 students, while forming a group shall not be allowed less than two or more than three students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statements for mini project in consultation with faculty supervisor/internal committee of faculties.
4	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
5	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
8	Students shall convert the best solution into working model using Python Programming.

9	The solution to be validated with proper justification and report to be compiled in standard format of the college.
10	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
11	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work

The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.

Continuous Assessment

In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.

	Distribution of Term work marks for both semesters shall be as below:	**Practical Marks**
1	Marks awarded by guide based on implementation	10
2	Peer assessment by team members	05
3	Marks awarded by review committee for presentation	05
4	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on project as mentioned in general guidelines

Project:

1	In this case in one semester students' group shall complete project in all aspects including, a. Identification of need/problem b. Proposed final solution c. Procurement of components/systems d. Building prototype and testing
2	Continuous assessment will be weekly based on logbook. Two presentations will be conducted for review before a panel. a. First shall be for finalization of problem and proposed solution b. Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1	Quality of survey and identification of problem statement

2	Innovativeness in solutions
3	Implementation
4	Team work
5	Project report
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
Mini Project shall be assessed based on following points:	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

Total Marks = Term work +Oral & Practical = (25+25)

25 marks of Term work will be given on the basis of evaluation of project practical marks and Log book which is filled weekly by students as per their weekly progress.

25 marks of Oral and practical will be based on a project implementation.

Course Code	Course Name	Credits (TH+P+TUT)
CEXS48	**Skill Based learning: Python Programming (SAT-V)**	**0 + 1 + 0**

Prerequisite:	Knowledge of programming language like C and Java
Skill Objectives:	1. Basics of Python programming 2. Decision Making, Data structure and Functions in Python 3. Object Oriented Programming using Python 4. Web framework for developing
Skill Outcomes:	**After successful completion of this course learner will be able to…** 1. To understand basic concepts in python. 2. To explore contents of files, directories and text processing with python 3. To develop program for data structure using built in functions in python. 4. To explore django web framework for developing python-based web application and basics of NumPy and Pandas 5. To understand Multithreading concepts using python. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Module	Sub Topics	SO mapped	Hrs / Sub topics	Total Hrs / Module
i. Prerequisitesand Course Outline	**Introduction to python, Features, Applications, Comparison with C and Java**			**02**
1. Python basics	Data types in python, Operators in python, Input and Output	**SO1, SO6**	**01**	**04**
	Control statement, Arrays in python		**01**	
	String and Character in python, Functions, List and Tuples, Dictionaries Exception		**01**	
	Introduction to OOP, Classes, Objects, Interfaces, Inheritance		**01**	
2. Advanced Python	Files in Python, Directories	**SO2, SO6**	**01**	**04**
	Building Modules		**01**	
	Packages, Text Processing		**01**	
	Regular expression in python		**01**	
3. Data Structure inPython	Link List, Stack	**SO3, SO6**	**02**	**04**
	Queues, Dequeues		**02**	
4. Python Integration Primer	Graphical User interface, Networking in Python	**SO4, SO6**	**01**	**04**
	Python database connectivity		**01**	
	Introduction to Django		**02**	
5.Multithreading	Thread and Process, Starting a thread	**SO5, SO6**	**01**	**04**
	Threading module, Synchronizing threads		**02**	
	Multithreaded Priority Queue		**01**	

6. NumPy and Pandas	Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types	**SO4, SO6**	**02**	**06**
	Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O		**02**	
	Basics of Pandas, Using multilevel series, Series and Data Frames, Grouping, aggregating, Merge Data Frames		**02**	
Total Hours				**28**

Books:	
Text Books	1. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press 2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication 3. Anurag Gupta, G. P. Biswas, "Python Programming", McGraw-Hill 4. E. Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Education
Reference Books	1. Zed A. Shaw, "Learn Python 3 the Hard Way", Zed Shaw's Hard Way Series 2. Martin C. Brown," Python: The Complete Reference", McGraw-HillPublication. 3. Laura Cassell, Alan Gauld, "Python Projects", Wrox Publication
Useful Links:	1. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/ 2. Beginning Perl, https://www.perl.org/books/beginning-perl/ 3. http://spoken-tutorial.org 4. https://starcertification.org/Certifications/Certificate/python

Suggested experiments using Python:

Sr. No.	Title of Experiments
1	Exploring basics of python like data types (strings, list, array, dictionaries, set, tuples) and control statements
2	Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
3	Exploring Files and directories a. Python program to append data to existing file and then display the entire file b. Python program to count number of lines, words and characters in a file. c. Python program to display file available in current directory
4	Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
5	Menu driven program for data structure using built in function for link list, stack and queue.
6	Program to demonstrate CRUD (**create, read, update and delete)** operations on database (SQLite/ MySQL) using python.
7	Creation of simple socket for basic information exchange between server and client.
8	Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).

9	Programs on Threading using python.
10	Exploring basics of NumPy Methods.
11	Program to demonstrate use of NumPy: Array objects.
12	Program to demonstrate Data Series and Data Frames using Pandas.
13	Program to send email and read content of URL.

Term Work for 25 Marks:

Programming labs to be conducted as 2 hrs continuous (theory + hands-on) session.The assessment will be

- An online quiz conducted at the end of every 2-hr session consisting of 5 questions for a total of 10 marks. The average of best 10 quizzes will be considered toward 10 marks.

- Students should perform minimum 10 experiments. The programs performed along with the screenshot of output have to be submitted within two days. A cover page will be attached stating the aims and objectives. This will be considered towards 10 marks.
- Attendance= 05 marks

	Spoken Tutorial Test	**Lab Submission**	**Total**
Marks Allotted	10	15	25

Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
CEXA49	**Ability Enhancement – SAT X: Skill Based Learning (Indian/Foreign Modern language)**	-	01	-	01
SBL Objectives (SOBs):	1. Acquire reading and writing proficiency in the target language 2. Understand the common heritage of, and diversity among, countries that speak the target language. 3. Communicate and interact effectively with citizens of the target cultures.				
SBL Outcome (SOs):	Upon completion of the course, the learners will be able to: 1. Demonstrate communicative proficiency in the target language. 2. Write the target language in formal expository prose that impede communication. 3. Learn through MOOC online courses to adopt hybrid mode of learning				
Guidelines for Skill- Based Learning(SBL) :	Each student has to complete any one Foreign and/or Indian Language MOOC course from NPTEL/Coursera/Udemy etc. sites referring the suggestive given list of course but are not limited to the list as it's a learner's choice for the interested course in the given semester time frame.				

Sr No.	Suggestive list of Courses-
1	Introduction to Japanese Language and Culture
2	German – II &III
3	The Psychology of Language
4	Spanish Vocabulary: Meeting People, Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project
5	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul
6	Complete French Course: Learn French for Beginners
7	Complete German Course: Learn German for Beginners
8	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced
9	Complete Japanese Course: Learn Japanese for Beginners
10	Complete Korean Course: Learn Korean for Beginners
11	The Complete Russian Language Course
12	Spoken Sanskrit: Basic and Intermediate Levels
13	Applied Linguistics

14	Fundamental Concepts in Sociolinguistics
15	Introduction to Basic Spoken sanskrit and intermediate level to Basic Spoken Sanskrit

Sr No	Suggestive Courses Link but are not limited to following resources only:
1	https://onlinecourses.nptel.ac.in/noc22_hs84/preview
2	https://onlinecourses.nptel.ac.in/noc22_hs89/preview
3	https://onlinecourses.nptel.ac.in/noc22_hs123/preview
4	https://www.coursera.org/learn/spanish-vocabulary-meeting-people https://www.coursera.org/learn/spanish-vocabulary-cultural-experience https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home https://www.coursera.org/learn/spanish-vocabulary-careers https://www.coursera.org/learn/spanish-vocabulary-project
5	https://www.coursera.org/learn/korean-beginners https://www.coursera.org/learn/learn-korean https://www.coursera.org/learn/learn-speak-korean1 https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul
6	https://www.udemy.com/course/complete-french-course/
7	https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/
8	https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/
9	https://www.udemy.com/course/complete-japanese-course-learn-japanese-for- beginners-lvl-1/
10	https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners- level-1/
11	https://www.udemy.com/course/the-complete-russian-language-course/
12	https://onlinecourses.nptel.ac.in/noc22_hs114/preview
13	https://onlinecourses.nptel.ac.in/noc22_hs85/preview
14	https://onlinecourses.nptel.ac.in/noc22_hs139/preview