GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE05000261
Subject Name: System Software

w.e.f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	Data Structures, Operating Systems, Microprocessor & Interfacing
Rationale:	System Software is an essential subject that explains how computer hardware and application software interact with each other. It provides knowledge of core components such as assemblers, compilers, loaders, linkers, and operating system services. The subject helps students understand how high-level programs are translated into machine-executable code. This subject strengthens problem-solving skills related to low-level system operations. Overall, System Software builds a strong foundation for designing efficient, reliable, and secure computing systems.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
CO-1	Explain and classify different methodologies, concepts and approaches to System Software Programming.	R, U
CO-2	Identify elements of language processors with various data structures used in development of one-pass and multi-pass assemblers.	R, A
CO-3	Examine macro processor, its usage and compare various loading and linking schemes.	U, A
CO-4	Build various system programs using language processor development tools such as YACC and Lex.	U, A
CO-5	Design code optimization– based solution for the given system Problems by applying various techniques of compiler, interpreter and debugger and Storage Allocation, Scope Mechanisms and data structures in programming languages.	U, A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Overview of System Software** Introduction, Software, Software Hierarchy, Systems Programming, Machine Structure, Interfaces, Address Space, Computer Languages, Tools, Life Cycle of a Source Program, Different Views on the Meaning of a Program, System Software Development, Recent Trends in Software, Development, Levels of System Software	03	5
2	**Overview of Language Processors** Programming Languages and Language Processors, Language Processing Activities, Program Execution, Fundamental of Language Processing, Symbol Tables Data Structures for Language Processing: Search Data structures, Allocation Data Structures.	04	10
3	**Assemblers** Elements of Assembly Language Programming, Design of the Assembler, Assembler Design Criteria, Types of Assemblers, Two-Pass Assemblers, One-Pass Assemblers, Single pass Assembler for Intel x86, Algorithm of Single Pass Assembler, Multi-Pass Assemblers, Advanced Assembly Process, Variants of Assemblers Design of two pass assembler	06	15
4	**Macro and Macro Processors** Introduction, Macro Definition and Call, Macro Expansion, Nested Macro Calls, Advanced Macro Facilities, Design of a Macro Pre- processor, Design of a Macro Assembler, Functions of a Macro Processor, Basic Tasks of a Macro Processor, Design Issues of Macro Processors, Features, Macro Processor Design Options, Two-Pass Macro Processors, One-Pass Macro Processors	07	15
5	**Linkers and Loaders** Introduction, Relocation of Linking Concept, Design of a Linker, Self-Relocating Programs, Linking in MSDOS, Linking of Overlay Structured Programs, Dynamic Linking, Loaders, Different Loading Schemes, Sequential and Direct Loaders, Compile-and-Go Loaders, General Loader Schemes, Absolute Loaders, Relocating Loaders, Practical Relocating Loaders, Linking Loaders, Relocating Linking Loaders, Linker's v/s Loaders	07	15
6	**Scanning and Parsing** Programming Language Grammars, Classification of Grammar, Ambiguity in Grammatic Specification, Scanning, Parsing, Top-Down Parsing, Bottom-up Parsing, Language Processor Development Tools, LEX, YACC	05	10
7	**Compilers** Causes of Large Semantic Gap, Binding and Binding Times, Data Structure used in Compiling, Scope Rules, Memory Allocation, Compilation of Expression, Compilation of Control Structure, Code Optimization	04	10

8	**Interpreters & Debuggers** Benefits of Interpretation, Overview of Interpretation, The Java Language Environment, Java Virtual Machine, Types of Errors, Debugging Procedures, Classification of Debuggers, Dynamic / Interactive Debugger	04	10
9	**Programming Languages:** Importance of High-Level Languages, Features of a High-Level Language, Data Types and Data Structures, Storage allocation and scope of Names, Accessing Flexibility, Functional Modularity, Asynchronous, Operation, Extensibility and compile Time	05	10
		TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks in %					
R Level	U Level	A Level	N Level	E Level	C Level
20	**40**	**20**	**20**	**0**	**0**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. System Programming by D M Dhamdhere, McGraw Hill Publication
2. System Software – An Introduction to Systems Programming by Leland L. Beck, 3rd Edition, Pearson Education Asia, 2000
3. Systems Programming by John J. Donovan, 1st edition, Tata McGraw-Hill, 1991, ISBN 0-07-460482-1
4. System Programming by Srimanta Pal, OXFORD Publication
5. System Programming and Compiler Construction by R.K. Maurya & A. Godbole.
6. System Software by Santanu Chattopadhyay, Prentice-Hall India,2007

List of Experiments:

1. Write a program to implement the lexical analyzer.
2. Write a Lexical Analyzer (using lex utility for UNIX).
3. Write a program to left factor the given grammar.
4. Write a program to remove the Left Recursion from a given grammar.
5. Aim: Implement Recursive Descendent Parsing for the given Grammar.
   E -> T + E / T
   T -> F * T / F F -> (E) / i
6. Implement Predictive Parser for the given grammar.
   E -> T + E / T

T -> F * T / F
F -> (E
) / i

7. Write a SAL program in text file and generate SYMTAB and LITTAB
8. Use macro features of C language
9. Write a program which generates Quadruple Table for the given postfix String
10. Write a C program to parse a given string using Predictive parsing for given grammar.
    type → simple | ↑id | array [simple] of
    type simple → integer | char | num
    dotdot num

List of Open-Source Software/learning website:

1. www.cs.jhu.edu/~scott/pl/lectures/parsing.html
2. www.en.wikipedia.org/wiki/System_programming
3. https://www.isi.edu/~pedro/Teaching/CSCI565-Fall15/Materials/LexAndYaccTutorial.pdf
4. https://developer.ibm.com/technologies/systems/tutorials/au-lexyacc/

List of suggested activities for Problem Based Learning:

Sl. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 3h each. Total = 15h	Based on the assignment submitted.
2	Programming	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based problems of 3h each. Total = 15h	Based on the coding solution submitted.
3	Video based learning	Technical Video based learning related to the subject	Duration of video = 5h Report preparation & Presentation= 10h Total = 15h	Report /presentation based on the video learning outcomes.
4	Poster/Chart/PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 10 h	Based on poster/chart preparation and presentation skills
5	Programming	Application/Software development	Duration = 15 h	Depending on the complexity of the Application/Software
6	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

7	Case Study Analysis / Seminar	Seminar / Presentation	Duration for study and preparation=5h Report writing=3h Presentation=2h Total=10h	Topic can be selected technical content beyond syllabus
8	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 10h Total = 15h	Based on in-depth study, technical depth, data collected, fact finding, etc.
9	Video based learning	Self-learning on-line course	Minimum duration of the course should be 15h.	Examination based assessment at the end of course. Based on the certificate produced

Note:

- All the suggested activity should be related to the subject.
- Min 3 activities must be carried out as per the availability of faculties and students.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.

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