Course Title	Numerical Methods, Operations Research & Statistics	Semester	IV
Course Code	MVJ19MIS41	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 3 : 1 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, sampling theory and Operational research emerging in science and engineering.

Module-1	L1,L2, L3	12 Hours

Numerical Methods-1

Numerical solution of Ordinary Differential Equations of first order and first degree: Modified Euler's method, Taylor's series method, Runge-Kutta method of fourth order, Predictor and Corrector method: Milne's Method and Adams-Bashforth Method.

Application: Solving Ordinary Differential Equations.

Video Links:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/

Module-2	L1,L2, L3	12 Hours

Numerical Methods-2:

Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Predictor and Corrector method: Milne's Method and Adams Bashforth Method.

Calculus of Variations: Variation of function and Functional, variational problems.

Euler's equation, Geodesics.

Application: Hanging chain problem.

Video Links:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/

Module-3	L1,L2, L3	12 Hours

Operations Research-1

Introduction to Linear Programming Problem (LPP): Prototype example, Assumptions of LPP, Formulation of LPP and Graphical method various examples. The simplex method, Big M method, Two phase method and dual simplex method.

Application: Graphical solution procedure.

Video Links:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/

Module-4	L1,L2, L3	12 Hours

Operations Research-2

The transportation problem: Initial Basic Feasible Solution (IBFS) by North West Corner Rule method, Matrix Minima Method, Vogel's Approximation Method.

Game Theory: The formulation of two persons, zero sum games; saddle point, maxmin and minmax principle, Solving simple games- a prototype example, Games with mixed strategies.

Application: Transportation problem.

Video Links: 1. http://nptel.ac.in/courses.php?disciplineID=111 2. http://www.class-central.com/subject/math(MOOCs) 3. http://academicearth.org/		
Module-5	L1,L2, L3	12 Hours
Statistical Methods Correlation and Regression: Correlation, Regression coefficients, line of regression problems. Curve fitting: Fitting of the curves of the form $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$ by the method of least squares. Application: Finding the best fit between two variables. Video Links: 1. http://nptel.ac.in/courses.php?disciplineID=111 2. http://www.class-central.com/subject/math(MOOCs) 3. http://academicearth.org/		

Course outcomes:	
CO1	Solve first and second order ordinary differential equation arising in flow problems using single step numerical methods.
CO2	Determine the extremals of functional and solve the simple problems of the Calculus of variations.
CO3	Solve the mathematical formulation of linear programming problem.
CO4	Solve the applications of transport problems and theory of games.
CO5	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.

Reference Books:	
1	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2	S. D. Sharma, "Operations Research", Kedar Nath and Ram Nath Publishers, Seventh Revised Edition 2014.

3	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.
4	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
5	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition
6	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (4 marks) Mini Project / Case Studies (8 Marks) Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
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CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	0	1
CO2	3	2	0	3	0	0	0	0	0	0	0	0
CO3	3	3	0	2	0	0	0	0	0	0	0	0
CO4	2	3	0	3	0	0	0	0	0	0	0	1
CO5	3	3	0	3	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	Design & Analysis of Algorithm	Semester	IV
Course Code	MVJ19IS42	CIE	50
Total No. of Contact Hours	50	SEE	50
No. of Contact Hours/week	5 (L : T : P :: 3 : 2 : 0)	Total	100
Credits	4	Exam. Duration	3 Hours

Course objective is to: Explain various computational problem-solving techniques. Apply appropriate method to solve a given problem. Describe various methods of algorithm analysis		
Module-1	**L1,L2, L3**	**12 Hours**
Introduction to Algorithms: The role of algorithms in computing, Growth of functions, Asymptotic notations, Designing and Analysing algorithms-an Introduction using insertion sort. Review on the Math needed for algorithm design and analysis. Laboratory Sessions/ Experimental learning: Implement insertion sort and test its efficiency Applications: Develop a realistic model for the input to the program. Analyse the unknown quantities, assuming the modelled input. Calculate the total running time by multiplying the time by the frequency for each operation, then adding all the products. Video link / Additional online information : https://www.tutorialspoint.com/data_structures_algorithms/asymptotic_analysis.htm		
Module-2	**L1,L2, L3**	**12 Hours**
Divide and Conquer: Solving recurrences – The Substitution method, Recurrence Tree method and Master's method, Multiplying large integers, Binary Search, Sorting		

[Merge Sort and Quick Sort], Selection in linear time [Expected and Worst-case], Strassen's algorithm for Matrix Multiplication, The maximum sub-array problem.

Laboratory Sessions/ Experimental learning:

Implement maximum sub array algorithm and test their correctness and efficiency

Applications: Closest Pair of Points, Strassen's Multiplication, Karatsuba Algorithm, Cooley-Tukey Algorithm

Video link / Additional online information :

https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_

divide_conquer_htm

Module-3	L1,L2, L3	12 Hours

Greedy Algorithms: Characteristics of Greedy algorithms, The problem of making change, Greedy algorithms for Scheduling, Minimum Spanning Trees – Kruskal's Algorithm and Prim's Algorithm, Greedy Algorithms for finding the shortest paths in a Graph, The Knapsack problem Amortized Analysis:

The accounting method, The potential method.

Laboratory Sessions/ Experimental learning:

Implement Knapsack Algorithm using Greedy method.

Applications: Dijkstra's Algorithm, Google Map

Video link / Additional online information :

https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_

greedy_method_htm

Module-4	L1,L2, L3	12 Hours

Dynamic Programming: Calculating the binomial co-efficient, the problem of making change,

The Knapsack problem, Chained matrix multiplication, Finding the shortest paths in a Graph, Reformulating Dynamic programming algorithms using recursion and memory functions.

Laboratory Sessions/ Experimental learning:

Implement single source shortest path algorithm.

Applications: Logistic/Transportation Problems

Video link / Additional online information :

https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_

dynamic_programming_htm

Module-5	L1,L2, L3	12 Hours

Backtracking: N-Queen's Problem -Graph colouring.

Branch and Bound: Assignment Problem - Traveling Salesman Problem. Computability classes – P, NP, NP-complete and NP-hard.

Laboratory Sessions/ Experimental learning:

Implement graph colouring Problem

Applications: Electrical Engineering, Robotics, Artificial Intelligence, Materials Engineering, Solving Puzzles

Video link / Additional online information :

https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_

p_np_class_htm

Course outcomes:	
CO1	Analyze the correctness of algorithms using induction and loop invariants.
CO2	Construct algorithms using design paradigms like divide and conquer, greedy and dynamic programming for a given problem.
CO3	Analyze how the performance of an algorithm is affected based on the choice of data structures the algorithm uses.

CO4	Construct graph-based algorithms to solve engineering problems.
CO5	Outline P and NP problems with the help of backtracking and branch and bound techniques

Reference Books:	
	Introduction to the Design and Analysis of Algorithms, Anany Levitin:, 2rd Edition, 2009.Pearson.
	Computer Algorithms/C++, Ellis Horowitz, Satraj Sahni and Rajasekaran, 2nd Edition, 2014, Universities Press
	Charles E. Leiserson, Thomas H. Cormen, Ronald L. Rivest, Clifford Stein – Introduction to Algorithms, Third edition, PHI, 2010.

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CO-PO Mapping												
CO/PO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	0	2	0	0
CO2	3	3	3	2	3	0	0	0	0	2	0	0
CO3	3	3	2	2	3	0	0	0	0	2	0	0
CO4	3	3	2	2	3	0	0	0	0	2	0	0
CO5	3	3	3	2	3	0	0	0	0	2	0	0

High-3, Medium-2, Low-1

Course Title	Microcontroller & Embedded Systems	Semester	IV
Course Code	MVJ19IS43	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4 (L: T : P :: 3 : 1 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

Explain the fundamentals of ARM based system, basic hardware components, selection methods and attributes of an ARM Controller.

Program ARM controller using the various instructions.

Explain the fundamentals of Exception, Interrupt Handling and Memory Management Unit of ARM Controller.

Identify the Embedded System Design applications.

Explain the real time operating system for the embedded system design.

Module-1	L1,L2, L3	12 Hours

Microprocessors versus Microcontrollers, ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software.

ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table , Core Extensions

Laboratory Sessions/ Experimental learning:

ARM Processor and Sample programs using Simulator.

Comparison of Microprocessor and Microcontroller hardware Model

Comparing the Microprocessor and Microcontroller Software Model

Applications: ARM Design

Video link / Additional online information :
https://developer.arm.com/architectures/platform-design/embedded-systems
https://www.youtube.com/watch?v=JPfG0UQd3x4
https://bnmbiw.wordpress.com/2013/01/27/chapter-1-arm-embedded-systems/

Module-2	L1,L2, L3	12 Hours

Introduction to the ARM Instruction Set : Data Processing Instructions , Programme Instructions, Software Interrupt Instructions, Program Status Register Instructions, Coprocessor Instructions, Loading Constants

ARM programming using Assembly language: Writing Assembly code, Profiling and cycle counting, instruction scheduling

Laboratory Sessions/ Experimental learning:
ARM assembly language programming

Applications: Writing Assembly code
Video link / Additional online information :
https://iitd-plos.github.io/col718/ref/arm-instructionset.pdf
https://www.slideshare.net/MathivananNatarajan/arm-instruction-set-60665439
https://www.scribd.com/document/401460874/ARM-Architecture

Module-3	L1,L2, L3	12 Hours

Exception, Interrupt Handling : Exception handling,Interrupts,Interrupt handling Schemes

Memory Management Unit : The Memory Hierarchy and Cache Memory, Cache Architecture, Cache Policy, Moving from MPU to an MMU,How Virtual Memory Works, Details of ARM MMU

Laboratory Sessions/ Experimental learning:

Use of External interrupt0 to turn ON/OFF led connected to Pin P1.25 of ARM Processor.

Use of Software Interrupt SWI instruction in programming.

Calculating physical memory address from logical address.

Applications: Estimation of CPU & Memory Performance

Video link / Additional online information :

https://www2.seas.gwu.edu/~bhagiweb/cs211/lectures/cache1.pdf

https://developer.arm.com/docs/den0024/a/the-memory-management-unit

https://www.youtube.com/watch?v=IyRNk5SMEpM

Module-4	L1,L2, L3	12 Hours

Embedded System Components: Embedded Vs General computing system, History of embedded systems, Classification of Embedded systems, Major applications areas of embedded systems, purpose of embedded systems

Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators, LED, 7 segment LED display, stepper motor, Keyboard, Push button switch, Communication Interface (on board and external types), Embedded firmware, Other system components.

Laboratory Sessions/ Experimental learning:

Mini project

Case Study: Digital Clock, Battery operated Smartcard Reader

Applications: Displaying digits on a 7-segment LED interface

Video link / Additional online information :

https://www.slideshare.net/MoeMoeMyint/introduction-to-embedded-system-chapter-2-4th-portion

https://shrishailbhat.com/2018/02/28/arm-microcontroller-embedded-systems-embedded-system-components/

https://mrcet.com/downloads/digital_notes/ECE/IV%20Year/EMBEDDED%20SYSTEMS%20DESIGN.pdf		
Module-5	**L1,L2, L3**	**12 Hours**
Real Time Operating System (RTOS) based Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread pre-emption, Multiprocessing and Multitasking, Task Communication (without any program), Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS Case Study: Automated Meter Reading System (AMR) and Digital Camera, Real time concepts Applications: Modern electronic systems Video link / Additional online information : https://www.geeksforgeeks.org/mutex-lock-for-linux-thread-synchronization/ http://digitalthinkerhelp.com/real-time-operating-system-rtos-examples-applications-functions/		

Course outcomes:	
CO1	Describe the architectural features and instructions of ARM microcontroller
CO2	Develop Assembly Programs in ARM for Embedded applications.
CO3	Describe the fundamentals of Exception, Interrupt Handling and Memory Management Unit of ARM Controller
CO4	Interface external devices and I/O with ARM microcontroller.
CO5	Demonstrate the need of real time operating system for embedded system applications

Reference Books:	
1.	Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developer's guide, Elsevier, Morgan Kaufman publishers, 2008.

2.	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education, Private Limited, 2nd Edition.
3.	Raghunandan...G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication, 2019
4.	The Insider's Guide to the ARM7 Based Microcontrollers, Hitex Ltd., 1st edition, 2005.
5	Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015.
6	Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

Quizzes/mini tests (4 marks)

Mini Project / Case Studies (8 Marks)

Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	0	0	0	0	0	0	0	0	0	0	0
CO2	3	2	1	0	0	0	0	0	0	0	0	0
CO3	0	0	2	3	0	0	0	0	0	0	0	0
CO4	0	0	2	3	0	0	0	0	0	0	0	0
CO5	0	0	3	0	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	Object Oriented Programming Concepts	Semester	IV
Course Code	MVJ19IS44	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 3 : 1 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

Learn fundamental features of object-oriented language and JAVA

Design, write, debug, run C++ and Java Programs

Develop console -based applications using C++

Develop console & windows applications using Java.

Introduce event driven Graphical User Interface (GUI) programming using applets and swings

Module-1	L1,L2, L3	12 Hours

Overview of OOPs Principles , Introduction to classes & objects , Instantiating and Using Classes with objects , Data Members , Member Functions , this Pointer , Constructor & Destructor , Control, Structures , Arrays in C++ .

Laboratory Sessions/ Experimental learning:

Introduction to OOP lab (Simple C program) - Classes and Objects.

Applications: Building a secure program using data hiding concept . Using same function or same operator having different purposes

Video link / Additional online information :

http://ee402.eeng.dcu.ie/introduction/chapter-1---introduction-to-object-oriented-programming

https://introprogramming.info/english-intro-csharp-book/read-online/chapter-20-object-oriented-programming-principles/

Module-2	L1,L2, L3	12 Hours

Derived Class and Base Class , Derived Class Constructors , Overriding Member Functions , Public and Private Inheritance , Types of Inheritance: Single, Multi-Level, Multiple, Hierarchical and Hybrid , Virtual Base Classes , Abstract Classes.

Laboratory Sessions/ Experimental learning:

Programs using constructor, inheritance

Applications: Reuse of existing class to derive a new class such that the redundant code is eliminated, which saves time and cost of program.

Video link / Additional online information :

https://isocpp.org/wiki/faq/private-inheritance

https://www.programiz.com/cpp-programming/public-protected-private-inheritance

https://balututorial.com/inheritance-in-c-with-example-program/

Module-3	L1,L2, L3	12 Hours

Pointers , this Pointer , Pointers to Objects and Derived Classes , Function Overloading , Operator Overloading , virtual function,

Friend Function , Static Function ,Streams: Stream Classes - Unformatted I/O Operations - Formatted Console I/O Operation.

Laboratory Sessions/ Experimental learning:

Program using function overloading, friend function

Applications: Dynamic linkage or late binding on the function

Video link / Additional online information :

https://www.cet.edu.in/noticefiles/285_OOPS%20lecture%20notes%20Complete.pdf

https://www.programiz.com/cpp-programming/friend-function-class

https://www.ntu.edu.sg/home/ehchua/programming/cpp/cp6_Inheritance.html

Module-4	L1,L2, L3	12 Hours
Java Basics , Classes and Objects , Inheritance, Interfaces , Abstract Class , packages , Exception handling, Type casting Laboratory Sessions/ Experimental learning: Programs using Java class/object, Package, interface Applications: Partial abstraction with abstract classes. Total abstraction with interfaces Video link / Additional online information : https://www.geeksforgeeks.org/object-oriented-programming-oops-concept-in-java/ https://www.edureka.co/blog/object-oriented-programming/		
Module-5	**L1,L2, L3**	**12 Hours**
Garbage Collections , Java Utility Classes , I/O Classes and Interfaces, Multithreading, Java swing basics Laboratory Sessions/ Experimental learning: Programs using thread concept, Java swing Applications: Partitioning the work of a project based on thread/objects. Video link / Additional online information : https://www.studytonight.com/java/garbage-collection.php https://beginnersbook.com/ 13/05/java-interface/ https://www.javatpoint.com/java-swing		

Course outcomes:	
CO1	Design class and objects for real world scenario.
CO2	Apply Inheritance concept to obtain code reusability.

CO3	Create applications to manipulate data from files using functions and streams
CO4	Develop console applications using Java OOPS.
CO5	Develop GUI application using Java library classes.

Reference Books:	
1.	E Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2011
2.	Sourav Sahay, Object Oriented Programming with C++ , 2nd Ed, Oxford University Press,2006
3.	Robert Lafore, Object Oriented Programming in C++, Galgotia Publication, 2010.
4.	Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education,2018
5.	D.T. Editorial Services ,Java 8 Programming Black Book , second edition, Dreamtech Press,2015

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CO2	0	2	2	0	3	0	0	0	0	0	0	0
CO3	0	2	1	0	3	0	0	0	0	0	0	0
CO4	0	1	2	0	3	0	0	0	0	0	0	0
CO5	0	1	2	0	3	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	Operating System	Semester	IV
Course Code	MVJ19IS45	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 3 : 1 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

Provide an understanding on the various components of an Operating System

The course focuses on fundamental problems and optimal solutions for resource management in operating systems such as process, disk and memory management

The course will introduce design principles and trade-offs in the design of Operating Systems.

Explain inter-process communication.

The course will also introduce the interface for interacting with a contemporary Operating system such as Linux.

Module-1	L1,L2, L3	12 Hours

Introduction to operating systems, What operating systems do; Computer System organization; Computer System architecture; Operating System operations; Process management; Memory management; Storage management; Protection and Security; Operating System Services; User - Operating System interface; System calls; Types of system calls; System programs; Operating system design and implementation; Operating System structure; Virtual machines. Process Management Process concept; Process scheduling; Operations on processes.

Case study:-IPC System

Laboratory Sessions/ Experimental learning:

Implementing process scheduling algorithms

Applications: Computer system.

Video link / Additional online information:

https://nptel.ac.in/courses/106108101/

Module-2	L1,L2, L3	12 Hours
Multi-threaded Programming: Overview; Multithreading models; Thread Libraries; Threading issues. Process Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors. CPU Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms; Thread scheduling; Multiple-processor scheduling Laboratory Sessions/ Experimental learning: Implementing process scheduling algorithms Applications: spell-check, response to keyboard, formatting Video link / Additional online information : https://www.smartzworld.com/notes/operating-systems-pdf-vtu-os/		
Module-3	**L1,L2, L3**	**12 Hours**
Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock. Memory Management: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. CASE STUDY: ARM architecture Laboratory Sessions/ Experimental learning: Implement Bankers algorithm for Dead Lock Avoidance Applications: Traffic gridlock Video link / Additional online information : https://www.smartzworld.com/notes/operating-systems-pdf-vtu-os/		

Module-4	L1,L2, L3	12 Hours
Virtual Memory Management: Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing. File System, File concept; Access methods; Directory and disk structure; File system mounting; File sharing; Protection; Case study's: NFS and WAFL File system Laboratory Sessions/ Experimental learning: Implement all page replacement algorithms Applications: scientific applications Video link / Additional online information : https://www.smartzworld.com/notes/operating-systems-pdf-vtu-os/		
Module-5	**L1,L2, L3**	**12 Hours**
Secondary Storage Structures, Protection: Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of access matrix, Access control, Revocation of access rights, Capability-Based systems. Linux overview – Kernel Architecture – Process, memory, file and I/O management – Inter Process communication and synchronization – Security. Case study of UNIX. Laboratory Sessions/ Experimental learning: Implementing disk scheduling algorithm Applications: NAS, Hard disk Video link / Additional online information : https://nptel.ac.in/courses/106108101/		

Course outcomes:	
CO1	Recognize the important computer system resources and the role of operating system in their management policies and algorithms.
CO2	Understand various scheduling algorithms.
CO3	Familiar with principles of deadlock and its prevention. To understand the concepts of file system interface.
CO4	Identify use and valuate the storage management policies with respect to different storage Management technologies
CO5	Identify the need to create the special purpose operating system.

Reference Books:	
1.	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts,Ninth Edition, John Wiley & Sons (ASIA) Pvt. Ltd, 2005.
2.	A.S.Tanenbaum, Operating System : Design and Implementation,Prentice Hall of India, 1989.
3.	J.L.Galvin and A.Silberschatz, Operating System Concepts,Addison-Wesley, 1998

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Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	2	2	2	0	0	2	0	2	2	0	3
CO2	0	3	2	2	0	0	2	0	2	2	0	2
CO3	0	3	2	2	0	0	2	0	2	2	0	2
CO4	0	2	2	2	0	0	2	0	2	2	0	3
CO5	0	3	2	2	0	0	2	0	2	2	0	2

High-3, Medium-2, Low-1

Course Title	Theory of Computation	Semester	IV
Course Code	MVJ19IS46	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 4 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

Acquire knowledge of Automata Theory as the basis of all computer science languages design

Understand the concept of Context Free Grammars and Languages

Learn the tools used for Lexical and Syntax analysis

Acquire knowledge of optimization

Enrich the knowledge in various phases of compiler ant its use

Module-1	L1,L2, L3	12 Hours

Introduction - Basic Mathematical Notation and techniques - Finite State systems - Basic Definitions - Finite Automaton - DFA & NDFA - Regular Languages- Regular Expression - Equivalence of NFA and DFA - Equivalence of NDFAs with and without input moves - Equivalence of finite Automaton and regular expressions - Minimization of DFA.

Laboratory Sessions/ Experimental learning:

Problems on DFA/NFA, regular expression

Applications: Text processing, compilers, and hardware design.Recognizing the pattern using regular expressions.

Video link / Additional online information :

https://www.youtube.com/watch?v=NeI1oOFlVtU

https://www.youtube.com/watch?v=_Z3XdgpE6_4

https://www.geeksforgeeks.org/regular-languages-and-finite-automata-gq/

Module-2	L1,L2, L3	12 Hours
Grammar Introduction - Types of Grammar - Context Free Grammars and Languages - Derivations and Languages - Ambiguity - Relationship between derivation and derivation trees - Simplification of CFG - Elimination of Useless symbols - Unit productions - Null productions - Pushdown Automata – Definitions - Moves - Instantaneous descriptions - Deterministic pushdown automata - Equivalence of Pushdown automata. Laboratory Sessions/ Experimental learning: Problems on CFG, pushdown automata Applications: CFGs can be used in programming languages, to study human language and in Artificial Intelligence . Video link / Additional online information : https://www.youtube.com/watch?v=ocLRMFr0TMI https://www.geeksforgeeks.org/ambiguity-in-context-free-grammar-and-context-free-languages/ https://www.cis.upenn.edu/~jean/gbooks/tcbookpdf2.pdf		
Module-3	**L1,L2, L3**	**12 Hours**
Introduction to Compiling - The grouping of phases - Compiler construction tools. The role of the lexical analyzer - Input buffering - Specification of tokens - Recognition of tokens - A language for specifying lexical analyzer Laboratory Sessions/ Experimental learning: Problems on lexical analysis Applications: Designing lexical analyzer of a compiler. Video link / Additional online information : http://www.vssut.ac.in/lecture_notes/lecture1422914957.pdf https://rmd.ac.in/dept/cse/notes/6/CD/unit1.pdf		

Module-4	L1,L2, L3	12 Hours
Syntax Analysis - The role of the parser - Context-free grammars - Writing a grammar - Top-down parsing - Bottom-up Parsing - SR parsers - LR parsers - Constructing an SLR (1) parsing table. Type checking - Type Systems - Specification of a simple type checker. Laboratory Sessions/ Experimental learning: Problems on syntax analysis, Construction of parsing table Applications: Designing the parsing phase of a compiler (Syntax Analysis). Video link / Additional online information : https://www.tutorialspoint.com/compiler_design/compiler_design_bottom_up_parser.htm https://www.geeksforgeeks.org/bottom-up-or-shift-reduce-parsers-set-2/ https://www.includehelp.com/compiler-design/introduction-to-bottom-up-parser.aspx		
Module-5	L1,L2, L3	12 Hours
Intermediate languages - Declarations - Assignment statements - Boolean expressions - Case statements -Backpatching - Procedure calls - Issues in the design of a code generator - The target machine - Run-time storage - management - Basic blocks and flow graphs - Next-use information - A simple code – generator - Register allocation and assignment - The dag representation of basic blocks - Generating code from DAGs Laboratory Sessions/ Experimental learning: Problems on DAG representation Applications: Generation of code for boolean expressions Video link / Additional online information : https://lecturenotes.in/notes/18736-note-for-compiler-design-cd-by-bineeth-kuriakose/13 http://www.vssut.ac.in/lecture_notes/lecture1422914957.pdf		

Course outcomes:	
CO1	Construct finite automata for given pattern and find its equivalent regular expressions.
CO2	Design and simplify context free grammar and find equivalent pushdown automata for given language.
CO3	Generate the machine code considering the functionalities involved in different phases of the compilation process.
CO4	Implement the parsing techniques including Bottom-up and Top-down parsing for the given programming construct described in Context Free Grammar
CO5	Design code generators for the specified machine and apply the various optimization techniques to speed up the compilation time.

Reference Books:	
1.	Hopcroft J E, Motwani R and Ullman J D, Introduction to Automata Theory, Languages and Computations, Second Edition, Pearson Education, 2012.
2.	Alfred V Aho, Ravi Sethi Jeffrey D Ullman, Compilers- Principles, Techniques, and Tools, Third Edition, Pearson Education Asia, 2009.
3	Steven S Muchnick, Advanced Compiler Design and Implementation, Second Edition, Morgan Kaufmann Pulishers, 2008.
4	Raghavan V, Principles of Compiler Design, Third Edition, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi, 2009

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (4 marks) Mini Project / Case Studies (8 Marks) Activities/Experimentations related to courses (8 Marks)
SEE Assessment:

Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	0	2	0	0	0	0	0	0	0	0	2
CO2	2	1	2	0	0	0	0	0	0	0	0	0
CO3	1	0	2	0	0	0	0	0	0	0	0	2
CO4	1	0	2	0	0	0	0	0	0	0	0	2
CO5	1	0	2	0	0	0	0	0	0	0	0	2

High-3, Medium-2, Low-1

Course Title	Design & Analysis of Algorithm Lab	Semester	IV
Course Code	MVJ19ISL47	CIE	50
Total No. of Contact Hours	30	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 0 : 1 : 2)	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to:

Understanding the basic algorithm techniques

Solve different algorithmic technique problems

Synthesize the efficiency of the algorithms in common engineering design situation

Sl No	Experiment Name	RBT Level	Hours
1	Implementation of Binary Search Trees	L3	4
2	Implementation of merge and quick sort algorithms and test their correctness and efficiency	L3	4
3	Implementation of Floyd-Warshall Algorithm and test their efficiency	L3	4
4	Implementation of 0/1 Knapsack problem using (a) Dynamic Programming method (b)Greedy method.	L3	4
5	(a) Implementation of all-Pairs Shortest Paths problem (b) Implementation of Travelling Sales Person problem	L3	4
6	Implementation and analysis of running time of eight-queen problem	L3	4
7	Implementation of insertion and topological sorting and test their efficiency.	L3	4
8	Program to find a subset of a given set S = {Sl, S2,.....,Sn} of *n* positive integers	L3	4
9	Program to find all Hamiltonian Cycles in a connected undirected Graph	L3	4
10	Mini Project /Case Presentation	L3	4

Course outcomes:	
CO1	Analyze the complexities of various problems
CO2	Apply different algorithmic design paradigms and methods of analysis
CO3	Analyzing the different complexity for different algorithmic techniques
CO4	Implement various algorithms in a high-level language
CO5	Compare the performance of different algorithms for same problem

CIE Assessment:
Regular Lab work :20 Record writing :5 Lab Tests(Minimum 2 tests shall be conducted for 15 marks and average of two will be taken) Viva 10 marks
SEE Assessment:
Examinations will be conducted for 100 marks and scaled-down to 50. The weightage shall be, Write-up : 20 marks Conduction : 40 marks Analysis of results : 20 marks Viva : 20 marks

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	0	2	0	0
CO2	3	3	3	2	3	0	0	0	0	2	0	0
CO3	3	3	2	2	3	0	0	0	0	2	0	0
CO4	3	3	2	2	3	0	0	0	0	2	0	0
CO5	3	3	3	2	3	0	0	0	0	2	0	0

High-3, Medium-2, Low-1

Course Title	Microcontroller & Embedded Systems Lab	Semester	IV
Course Code	MVJ19ISL48	CIE	50
Total No. of Contact Hours	30	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 0 : 1 : 2)	Total	100
Credits	2	Exam. Duration	3 Hours

Sl No	Experiment Name	RBT Level	Hours
1	Write a program to find the sum of first 10 integer numbers.	L3	2
2	Write a program to find factorial of a number.	L3	3
3	Write a program to add an array of 16 bit numbers and store the 32 bit result in internal RAM	L3	3
4	Write a program to find the square of a number (1 to 10) using look-up table.	L3	3
5	Write a program to find the largest/smallest number in an array of 32 numbers	L3	3
7	Write a program to count the number of ones and zeros in two consecutive memory locations	L3	3
8	Write an ARM assembly program that checks if a 32-bit number is a palindrome. Assume that the input is available in r 3. The program should set r 4 to 1 if it is a palindrome, otherwise r 4 should have 0. A palindrome is a number which is the same when read from both sides. For example, 1001 is a 4 bit palindrome.	L3	3
9	Display "Hello World" message using Internal UART	L3	3
10	Interface and Control a DC Motor	L3	3
11	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction	L3	3
12	Interface a DAC and generate Triangular and Square waveforms.	L3	3

13	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in Between	L3	3

Course outcomes:	
CO1	Describe the internal architecture of microcontroller systems, including counters, timers, ports, and memory
CO2	Develop programs using ARM7TDMI/LPC2148.
CO3	Test programs using ARM7TDMI/LPC2148
CO4	Conduct experiments on an ARM7TDMI/LPC2148 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.
CO5	Interface a microcontroller system to user controls and other electronic systems.

CIE Assessment:
Regular Lab work :20 Record writing :5 Lab Tests(Minimum 2 tests shall be conducted for 15 marks and average of two will be taken) Viva 10 marks
SEE Assessment:
Examinations will be conducted for 100 marks and scaled-down to 50. The weightage shall be, Write-up : 20 marks Conduction : 40 marks Analysis of results : 20 marks Viva : 20 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	0	0	0	0	0	0	0	0	0	0	0
CO2	3	2	1	0	0	0	0	0	0	0	0	0
CO3	0	0	2	3	0	0	0	0	0	0	0	0
CO4	0	0	2	3	0	0	0	0	0	0	0	0
CO5	0	0	3	0	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	BALIKE KANNADA	Semester	IV
Course Code	MVJ19BK49	CIE	50
Total No. of Contact Hours	15	SEE	50
No. of Contact Hours/week	1 (L : T : P :: 1 : 0 : 0)	Total	100
Credits	1	Exam. Duration	3Hrs

Course objective :This course will enable students to understand Kannada and communicate in Kannada language

Vyavharika Kannada –Parichaya (Introduction to Vyavharika kannada)

Kannada Aksharamaale haagu uchcharane(Kannada Alphabets and Pronounciation.

Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).

Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)

Activities in Kannada

CHAPTER-1
Vyavharika Kannada –Parichaya (Introduction to Vyavharika kannada)
CHAPTER-2
Kannada Aksharamaale haagu uchcharane(Kannada Alphabets and Pronounciation
CHAPTER-3
Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
CHAPTER-4
Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)
CHAPTER-5
Activities in Kannada

Scheme of Evaluation:

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
Total		100

Course Title	SAMSKRUTHIKA KANNADA	Semester	IV
Course Code	MVJ19SK49	CIE	50
Total No. of Contact Hours	15	SEE	50
No. of Contact Hours/week	1 (L: T: P :: 1 : 0 : 0)	Total	100
Credits	1	Exam. Duration	3Hrs

Course objective :This course will enable students to understand Kannada and communicate in Kannada language Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada) Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha) Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha) Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu) Activities in Kannada.
CzsÁåAiÀÄ -1
PÀ£ÀßqÀ ¨sÁµÉ-¸ÀAQë¥ÀÛ «ªÀgÀuÉ.
CzsÁåAiÀÄ -2
¨sÁµÁ ¥ÀæAiÉÆÃUÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ.
CzsÁåAiÀÄ -3
¯ÉÃR£À ªÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃU.À
CzsÁåAiÀÄ -4
¥ÀvÀæ ªÀåªÀºÁgÀ.
CzsÁåAiÀÄ -5
DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ.
CzsÁåAiÀÄ -6
¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ
CzsÁåAiÀÄ -7
¸ÀAQÃ¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É, ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ
CzsÁåAiÀÄ -8

PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ

CzsÁåAiÀÄ -9

PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À

CzsÁåAiÀÄ -10

¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ.

Scheme of Evaluation:

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
Total		100

Course Title	Additional Mathematics-II (Common to all branches)	Semester	IV
Course Code	MVJ20MISDIP401	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	-	Exam. Duration	3 Hours

Course objective is to: This course viz., aims to prepare the students:

- To familiarize the important and basic concepts of Differential calculus and Differential
  Equation, ordinary/partial differential equations and Vector calculus and analysethe engineeringproblems.

Module-1	L1,L2	8Hrs.

Linear Algebra:
Introduction,Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix and Problems.
Video Link:
https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf
https://nptel.ac.in/content/storage2/courses/122104018/node18.html

Module-2	L1,L2	8 Hrs.

Differential calculus:
Tangent and normal, sub tangent and subnormal both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems
Beta and Gamma functions:
Beta functions, Properties of Beta function and Gamma function ,Relation Between beta and Gamma function-simple problems.
Video Link:
https://www.youtube.com/watch?v=6RwOoPN2zqE
https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11
http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

Module-3	L1,L2	8Hrs.
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems. Video Link: https://www.toppr.com/guides/maths/three-dimensional-geometry/ https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/		
Module-4	**L1,L2,L3**	**8 Hrs.**
Probability: Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution-Binomial distribution, Mean and variance Binomial distribution -Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems. Video Link: https://nptel.ac.in/courses/111/105/111105041/ https://www.mathsisfun.com/data/probability.html		
Module-5	**L1,L2,L3**	**8 Hrs.**
Partial differential equation: Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Video Link: http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method- of- variation-of-parameters		
Course outcomes:		
CO1	Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems.	
CO2	Demonstrate various physical models ,find Maxima and Minima for a function of one variable., Point of inflections and Problems .Understand Beta and Gamma function	
CO3	Understand the 3-Dimentional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance .	
CO4	Concepts OF Probability related to engineering applications.	
CO5	Construct a variety of partial differential equations and solution by exact methods.	

Text Books:	
1	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
Reference Books:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014.
2	G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignments (10 marks)
SEE Assessment:
iv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. v. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. vi. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	2	0	0	0	0	0	0	1	1
CO2	3	3	0	2	0	0	0	0	0	0	1	1
CO3	3	3	0	3	0	0	0	0	0	0	0	1
CO4	2	2	0	3	0	0	0	0	0	0	1	1
CO5	2	2	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1