Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **Mathematical Simulation Lab**		Course Code	: **15EC24P**
Semester	: **II**	Course Group	: **Core**
Teaching Scheme in Hr (L:T:P)	: **0:2:4**	Credits	: **3**
Type of course	: **Tutorial + Practical**	Total Contact Hours	: **78**
CIE	: **25 Marks**	SEE	: **50 Marks**

Prerequisites

1. Familiarity and working knowledge of personal computer.
2. Elementary knowledge of computer programming and basic understanding of matrices, linear algebra, calculus, trigonometric functions and geometry.

Course Objectives

Familiarization of the syntax, semantics, data-types and library functions of numerical computing languages such as MATLAB and/or SCILAB, and application of such languages for implementation/simulation and visualization of basic mathematical functions relevant to electronics applications.

Course Outcomes

On successful completion of the course, the students should be able to

1. Understand the need for simulation/implementation for the verification of mathematical functions.
2. Understand the main features of the MATLAB/SCILAB program development environment to enable their usage in the higher learning.
3. Implement simple mathematical functions/equations in numerical computing environment such as MATLAB/SCILAB.
4. Interpret and visualize simple mathematical functions and operations thereon using plots/display.
5. Analyze the program for correctness and determine/estimate/predict the output and verify it under simulation environment using MATLAB/SCILAB tools.

Course Outcome		CL	Experiments linked	Linked PO	Teaching Hrs
CO1	Understand the need for simulation/implementation for the verification of mathematical functions.	***R/U/A***	Unit 1, Chapter 1	1,2,10	06
CO2	Understand the main features of the MATLAB/SCILAB program development environment to enable their usage in the higher learning.	***R/U/A***	Unit 1, Chapter 2&3	1,2,10	18
CO3	Implement simple mathematical functions/equations in numerical computing environment such as MATLAB/SCILAB.	***R/U/A***	Unit 2, Expts1 to 7	1,2,3,4,5, 8,10	21
CO4	Interpret and visualize simple mathematical functions and operations thereon using plots/display.	***U/A***	UNIT 2, Expts 7 to 14	1,2,3,4,5, 8,10	21
CO5	Analyze the program for correctness and determine/estimate/predict the output and verify it under simulation environment using MATLAB/SCILAB tools	***U/A***	UNIT 2, Expts 15	1,2,3,4,5, 8,9,10	06
		Total sessions include two tests			**78**

Course-Po Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Mathematical Simulation Lab	**3**	**3**	**3**	**3**	**3**	**--**	**--**	**3**	**1**	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Contents

UNIT – I: Tutorial and Practice Duration: 24 Hr.

Demonstrate the following with reference to MATLAB/ SCILAB (either one or both) environments.

Tutorial		
Sl. No.	**Topic/Exercises**	**Duration (Hr.)**
1.	**Introduction** 1. Definition, need, and types of programming languages and their selection criterion. 2. Introduction to MATLAB/SCILAB (Features, capabilities and applications) and development environment. 3. Program execution process. 4. Program format. 5. Concept and examples of built-in functions and the concept of toolboxes. 6. Variables and constants: Definition, naming (identifiers or labels for different entities), initialization and accessing of variables. Constants and their representation. 7. Data types-classification, memory requirement, range of values, usage and type specifiers. 8. Operators and Operands: Unary and binary operators. Arithmetic, logical, relational, combinational-assignment and special operators. Precedence and associativity. Unary and binary operands. 9. Statements-tokens and expressions. 10. Standard input and output statements and plot functions. 11. Escape characters.	06
2	**Control structure** 1. Branching: Conditional (if, if-else, nested and ladder if-else, switch constructs) and unconditional (break, continue and go to statements). 2. Looping: Entry controlled (for and while).	06
3	**Arrays/Matrices and strings** 1. Definition, declaration, initialization (static and run-time or dynamic) and arrays, matrices and strings. 2. Accessing of strings, array and matrices elements and relevant operations.	06
4	**Functions** 1. Concept, advantages, classification, creation and application of functions. 2. Comparison of built-in, library and user-defined functions.	06
	Total Duration (Hr.)	**24**

Practice	
1.	**Write program for the following problems (Assume right units. Search and use library functions wherever possible). Unless specified, built-in functions may be used if necessary.** 1. Display your country name. 2. Compute the area and circumference of a circle given the radius. 3. Compute simple interest given the interest rate, principal and duration. 4. Compute compound interest given the interest rate, principal, compounding-nature and duration. 5. Swap contents of two variables without using intermediate variables. 6. Factorial of a single digit number. 7. Absolute value of a number. 8. Largest of three numbers. 9. Logarithm of a number. 10. $Y=sin(\theta_1+\theta_2)+cos(\theta_1-\theta_2)$ given $\theta_1$and $\theta_2$in degrees. 11. Average of N numbers read through keyboard (at run-time). 12. Average of the numbers in 3x4 matrix. 13. Plot discharging voltage across capacitor.
2	**Analyze the program** Given the program or block of program (Matlab or Scilab), analyze the program and estimate/predict/record the output or error as the case may be. Instruct the student to justify the answer/output. [For e.g., A=246; B=-90; C=A+B*(10/A) +100; sprintf ('%f', C); in Matlab] Such analysis should be carried out for all the concepts covered in this course.

UNIT – II: Graded Exercises — Duration: 54 Hr.

Write the algorithm/flow-chart and code for the following problems (Assume appropriate data and units wherever necessary. Built-in functions can be used wherever necessary unless specified).

Sl. No.	Topic/Exercises	Duration (Hr.)
1	Addition, subtraction and multiplication of two matrices.	3
2	Verify whether the given matrix is singular or non-singular and compute its inverse if applicable.	3
3	Sorting of 1-D array and searching of an array/matrix. Also, list the set of numbers that obey a common condition in an array/matrix using *find ( )*.	3
4	Solve simultaneous equations (maximum of three) using Cramer's rule. [Simultaneous equations may be obtained by applying KCL or KVL for a circuit and they can be solved for voltages or currents, respectively]	3
5	(a) Show that $log_{10}(A*B)=log_{10}A+log_{10}B$ and $log_{10}(A/B)=log_{10}A-log_{10}B$ (b) Plot the voltage across capacitor during charging $V_c=V_0[1-e^{-(t/RC)}]$	3
6	(a) Plot a straight line for the given slope and intercept using different plot attributes. (b) Differentiate and integrate $y=mx+c$, separately, and display the results on the same plot.	3
7	Plot$y_1=A*sin(2\pi f_1 t)$, $y_2=B*cos(2\pi f_2 t)$ and $y_3=A*sin(2\pi f_1 t)+B*cos(2\pi f_2 t)$,in time and frequency (after computing DFT or FFT) domains as subplots	3

	and infer the results.	
8	Integrate and differentiate *sin(x)* and display the results on the same plot in different colors. Also display *sin(x)* on the same plot,	3
9	Validate $\int\{f(x)\pm g(x)\}dx=\int f(x)dx\pm\int g(x)dx$ for given trigonometric functions *f(x)* and *g(x)* visually/through plots.	3
10	Compute mean, median, standard deviation and variance of a set of data using formulae and verify using built-in functions.	3
11	Find all the even and prime numbers between two numbers (range).	3
12	Demonstrate (a) reading and display image, (b) converting color image to gray and black-and-white and plotting their histograms, and (c) conversion of image file formats.	3
13	Compare the results of the built-in and user-defined function to compute *cos(x)* [the series $cos(x)=1-(x^2/2!)+(x^4/4!)-(x^6/6!)+$ ... can be used]	3
14	Write a program to compute roots of a quadratic equation $ax^2+bx+c=0$ given *a, b* and *c*.	3
15	Two open-ended experiments of similar nature and magnitude of the above are to be assigned by the teacher (Student is expected to solve and execute/simulate independently).	6
	Two Internal Assessment Tests	6
	Total Duration (Hr.)	**54**

References

1. MATLAB and its Applications in Engineering, RajkumarBansal, Pearson Publishers, ISBN-10: 8131716813, 2009.
2. SCILAB(a Free Software to Matlab),Er. HemaRamachandran and Dr. Achutsankar Nair, S. Chand Publishers, ISBN-10: 8121939704,2011
3. http://in.mathworks.com/
4. https://www.scilab.org/resources/documentation/tutorials

Course Delivery

The course will be normally delivered through two-hour tutorials and four-hour hands-on practice per week. In Unit-I, tutorials and practice are carried out concurrently. One-hour tutorial followed by two-hour hands-on practice for each of the graded exercises is recommended. However, graded exercise can also be covered at appropriate point of tutorials of Unit-I.

Course Assessment and Evaluation Scheme

Method	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course Outcomes
DIRECT ASSESSMENT	CIE (Continuous Internal Evaluation)	IA Tests	Students	Two IA Tests(Average of two tests will be computed)	10	Blue books	1 to 5
				Record Writing (Average of Marks allotted for each experiment)	10	Record Book	1 to 5
				Quiz	05	Quiz Sheet	1 to 5
				Total	25		
	SEE (Semester End-Examination)	End Exam		End of the course	50	Answer scripts at BTE	1 to 5
INDIRECT ASSESSMENT	Student Feedback on course		Students	Middle of the course		Feedback forms	1 to 3 Delivery of course
	End of Course Survey			End of the course		Questionnaires	1 to 5 Effectiveness of Delivery of instructions & Assessment Methods

***CIE** – Continuous Internal Evaluation ***SEE** – Semester End Examination

Note:

1. I.A. test shall be conducted as per SEE scheme of valuation. However obtained marks shall be reduced to 10 marks. Average marks of two tests shall be rounded off to the next higher digit.
2. Rubrics to be devised appropriately by the concerned faculty to assess Student activities.

MODEL OF RUBRICS FOR ASSESSING STUDENT ACTIVITY

Dimension	Scale					Students exam Reg no/ Score				
	1.Unsatisfactory	2.Developing	3.Satisfactory	4.Good	5.Exemplary	Reg1	Reg2	Reg3	Reg4	Reg5
1.Research and gather information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3				
2.Full fills teams roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2				
3.Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5				
4.listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3				
					Total Marks	13/4=3.25=04				

Composition of Educational Components

Questions for CIE and SEE will be designed to evaluate the various educational components such as shown in the following table.

Sl. No.	Component	Weightage(%)
1	Remembering and Understanding	25
2	Applying the knowledge acquired from the course	35
3	Analysis	40

Scheme of Evaluation for Semester End Exam

Sl. No.	Scheme	Max. Marks
1	Short questions on Unit-I (only write-up)	10
2	Writing steps /Algorithm/Procedure and program for two questions from the graded exercises.	15
3	Execution/Implementation/Simulation/Interpretation of either one of theprograms written in 2.	15
4	Open-ended problem (Problems not covered in Sl. No. 15 of graded exercise): Writing program andits execution/implementation.	05
5	Viva-voce	05
	Total	**50**

Note:

1. Candidate shall submit laboratoryrecord for the examination.
2. Student shall be allowed to execute the program even if she/he unable to write the procedure/steps/algorithm.
3. Writing code, execution/implementation of an open-end problem of the nature and magnitude specified in Unit-II.

Laboratory Resource Requirements

Hardware Requirement: For a batch of 20 students.Computers to students ratio in the laboratory should be 1:1 for a batch of twenty students.

Sl. No.	Equipment	Quantity
1	PC systems (latest configurations)	20
2	Laser Printers	01
3	Broad Band Connection	01
4	Modern Projector set-up	01
5	LAN Switch for Networking(LAN Switch for Networking – 20 Computers)	01
6	UPS with Batteries(3Hr Backup)	01
7	Air Conditioning System	01

Software Requirement: Linux / equivalent Operating System, SCILAB (open-source) or MATLAB.

Model Questions for Semester End Examination

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Write algorithm/flowchart/steps/procedure and programs to solve the following problems. Execution/ implementation of the programs is under MATLAB or SCILAB environment. This list is only indicative but not exhaustive.

1. Add, subtract and multiply two 3x3 matrices.
2. Verify if the given matrix is singular or non-singular. Find its inverse if applicable.
3. Count number of fail students among N students given their total marks. Also identify the student who has scored exactly 75% and list the students based on their total-marks.
4. Solve the given three simultaneous equations using Cramer's rule.
5. Plot the voltage across a charging capacitor in an RC circuit. Also demonstrate that $log_{10}(A*B)=log_{10}A+log_{10}B$.
6. Convert a $A+jB$ to $P\angle Q$ and vice-versa.
7. Plot a straight line for the given slope m and intercept C using different line attributes. Integrate and differentiate the line and plot the results on the same plot.
8. Plot $y_1=A*sin(2\pi f_1 t)$, $y_2=B*cos(2\pi f_2 t)$ and $y_3=A*sin(2\pi f_1 t)+B*cos(2\pi f_2 t)$, in time and frequency (after computing DFT or FFT) domains as subplots.
9. Validate $\int\{f(x)\pm g(x)\}dx=\int f(x)dx\pm\int g(x)dx$ for given trigonometric functions $f(x)$ and $g(x)$ visually/through plots.
10. Compute mean, median, standard deviation and variance of a set of data such as ages or total marks of 25 students using formulae and verify using built-in functions.
11. Find all the odd and prime numbers between two numbers (range) 3 and 200.
12. Demonstrate (a) reading and display of image of a color image, (b) converting color image to gray and black-and-white and plotting their histograms, and (c) conversion of image file formats from bmp to jpg and tiff.
13. Compare the results of the built-in function and user-defined function used to compute $cos(x)$.
14. Write a program to compute roots of a quadratic equation $ax^2+bx+c=0$ given a, b and c.
15. Two open-ended experiments of similar to the above are to be assigned by the teacher (Student is expected to solve and execute/simulate independently).
    For example,
    i. Find the factorial of a number using while loop
    ii. Plot the forward characteristics of a PN junction diode

End