Course Title :CIRCUITS SIMULATION LAB		Course Code :15EE37P
Semester :**III**		Course Group : **Core**
Teaching Scheme (L:T:P) : **0:2:4** (in Hours)		Credits : **3 Credits**
Type of course : **Tutorial + Practical**		Total Contact Hours : **78**
CIE : **25 Marks**		SEE : **50 Marks**
Programme: ELECTRICAL AND ELECTRONICS Engg**.**		

Pre-requisites:

1. Basics knowledge of working on Personal Computer and Basic Computer Skills Lab.
2. Basic knowledge of Applied Mathematics, Elements of Electrical Engg., Electrical Circuit theory, Analog and Digital Electronics.

Course Objectives:

1. To impart practical working knowledge of Electrical and Electronics Simulation and Analysis using Mathematical computing languages such as MATLAB and/or SCILAB.

2. To Solve, Simulate and Analyse basic Electrical and Electronics Circuits and Applications by writing Ohm's law, KCL and KVL Mathematical Equations and Programs.

3. **To develop hands on working experience with reference to Solve, Simulate and Analyse Electrical & Electronics Circuits using MATLAB or SCI LAB environments.**

Course Outcomes:

On successful completion of the Course, the student will be able to:

1. Understand the main features and importance of the MATLAB/ SCI LAB mathematical programming environment.

2. Apply working knowledge of MATLAB/ SCI LAB package to simulate and solve Electrical, Electronics circuits and Applications.

3. Solve, Simulate and Analyse various DC circuits.

4. Solve, Simulate and Analyse various AC circuits.

5. Solve, Simulate and Analyse various Analog and Digital Electronics circuits.

6. Solve, Simulate and Analyse simple Transformer and DC Generator circuits.

Unit I: Tutorials and Practice   **Duration: 16 Hr.**
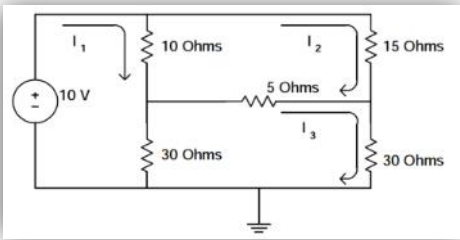
Reference free e-Book: Book 4

1. **To develop hands on working experience with reference to Solve, Simulate and Analyze Electrical & Electronics Circuits using MATLAB or SCI LAB environments.**

2. **The following TUTORIALS MAY BE CARRIED OUT/ EXPLAINED in a similar way explained in PRESCRIBED/SUGGESTED REFERENCE BOOKS.**

3. **The following Tutorials may be exercised/ taught in BRIEF only TO THE EXTENT OF UNDERSTANDING TO SIMULATE and obtain results for the suggested Graded Exercises.**
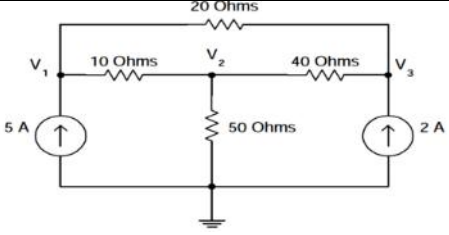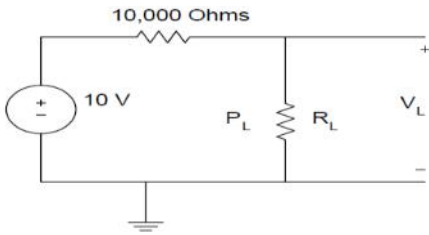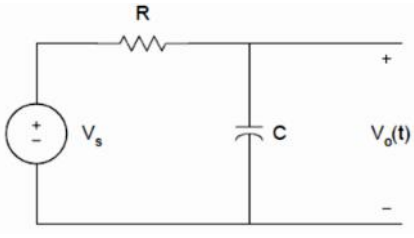
Tutorial		
Sl. No.	**Topic/ Exercises**	**Duration (Hr.)**
1.	**Introduction to MATLAB/ SCI LAB;** features, applications and software versions, STARTING and QUITTING, MATLAB DESKTOP	01
2.	DESKTOP TOOLS; *Command Window, Command History, Launch Pad, Help Browser, Current Directory Browser, Workspace Browser, Editor/ Debugger*	01
3.	GETTING STARTED *MATLAB*; *Using it as a calculator, Creating variables, Overwriting variable, Error messages, Making corrections, Controlling the hierarchy of operations or precedence, Controlling the appearance of floating point number, Managing the workspace* *Keeping track of your work session, Entering multiple statements per line, Getting help*	02
4.	MATHEMATICAL FUNCTIONS; *Examples* BASIC PLOTTING; *Creating simple plots, Adding titles, axis labels, and annotations, Multiple data sets in one plot, Specifying line styles and colors, Copy/Paste Figures, Saving Figures*	02
5.	WORKING WITH MATRICES; *Introduction, Matrix generation*	01
6.	ARRAY OPERATIONS; *Matrix arithmetic operations, Array arithmetic*	02

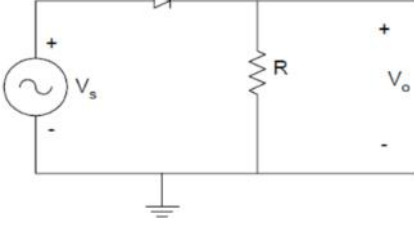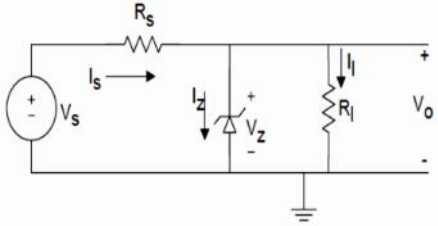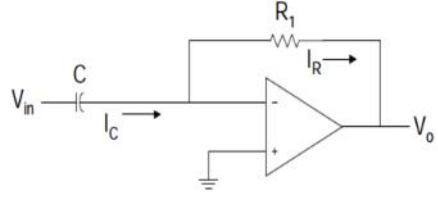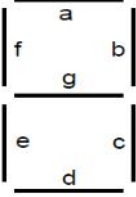|		
	operations	
	SOLVING LINEAR EQUATIONS; *Matrix inverse, Matrix functions*	
7.	**INTRODUCTION TO PROGRAMMING IN MATLAB** INTRODUCTION, M-FILE SCRIPTS; *Examples, Script side-effects* M-FILE FUNCTIONS; *Anatomy of a M-File function, Input and output arguments,* INPUT/OUTPUT COMMANDS	02
8.	**CONTROL FLOW AND OPERATORS** INTRODUCTION, CONTROL FLOW; *The ''if...end'' structure, Relational and logical operators, The ''for...end'' loop, The ''while...end'' loop, Other flow structures, Operator precedence,* SAVING OUTPUT TO A FILE	02
9.	**DEBUGGING M-FILES;** INTRODUCTION, DEBUGGING PROCESS; *Preparing for debugging, Setting breakpoints , Running with breakpoints, Examining values , Correcting and ending debugging , Ending debugging, Correcting an M-file.*	02
10	**SUMMARY OF COMMANDS, MAIN CHARACTERISTICS OF MATLAB**; History, Strengths, Weaknesses, Competition	01

List of Graded Exercises/ Simulations:

Unit II: Graded Exercises   **Duration: 56 Hr.**

Reference free e-Book :Book6 and 7

1. **The staff in-charge will give the problem/ circuit/equations to be simulated and explain the equations involved and method to formulate equations.**

2. **The student will solve/ formulate the equations, write the simplest possible program/ code/ M-file and simulate on software and obtain the results.**

3. **Questions will not be asked in specific like functions, control flow, method, etc. to test the programming capability of student, rather the emphasis is to learn to simulate the given exercise.**

4. **Built-in functions can be used wherever necessary.**

Sl. No.	Topic/Exercises	Duration (Hr.)
1	Ohm's law - If R = 10 Ohms and the current is increased from 0 to 10 A with increments of 2A.Write a program/ simulate to generate a table of current, voltage and power dissipation.	3
2	Resistances combination- Write a program/ simulate to solve the equivalent resistance of series and parallel combinations up to three resistances R1, R2 and R3.	3
3	KVL- Using Mesh/ loop analysis solve and simulate the given circuit to find the loop currents I_1, I_2 and I_3.	3
4	KCL- Using Nodal analysis, solve and simulate the given circuit to find the nodal voltages V_1, V_2 and V_3.	3

5	Maximum Power Transfer theorem- In figure the R_L varies from 0 to 50 k Ω, Write a program and simulate to plot the power dissipated by the load. Verify that the maximum power dissipation by the load occurs when R_L is 10 kΩ.	
6	Impedance and Admittance- Simplify following impedance Z and express it both in rectangular and polar form. Also compute Admittance Y. $$Z = \frac{(3+j4)(5+j2)(2\angle 60^0)}{(3+j6)(1+j2)}$$	3
7	RL ac circuit- For an series R-L circuit, the voltage $v(t)$ and current $i(t)$ are given as; $$v(t) = 10\cos(377t)$$ $$i(t) = 5\cos(377t + 60^0)$$ Simulate the above condition and plot a sketch of $v(t)$ and $i(t)$ for $t = 0$ to 20 milli seconds.	3
8	RC circuit- For the figure shown, the input voltage is a rectangular pulse with an amplitude of 5 Volts and a width of 0.5 sec. $C = 10$ μF and $R = 1000$ kΩ. Write a program and simulate to plot the output voltage $V_0(t)$ from zero seconds and end at 1.5 seconds.	3
9	Half Wave Rectifier- A half-wave rectifier circuit is shown in figure. It consists of an alternating current (ac) source, a diode and a resistor. Write a	3

program and simulate to obtain the input and output plots. Assume suitable values for the ac source and time frame.

10	Zener Voltage Regulator- A zener voltage regulator circuit of figure has the following data: $30 \leq V_S \leq 35\text{V}; \quad R_L = 10\text{K}, \quad R_S = 2\text{K}$ Write a program to obtain the Breakdown characteristics and calculate the output voltage Vs = 30 Volts and Vs = 35 Volts.	3
11	OPAMP Differentiator- For the figure given assume suitable values for Input voltage and circuit components. Write a program and simulate to show a plot for OPAMP differentiator operation.	3
12	Number System- Write a program and obtain code conversion for the following. a). $(99)_{10} = (?)_2$ b). $(10011100)_2 = (?)_{10}$ c). $(6F9)_{16} = (?)_2$ and $(?)_{10}$	3
13	Logic gates- Write a program/ script file that produces a truth tables for the NOT, AND, OR, NAND, NOR, and EXOR operations. Take a and b inputs as 4 bits.	3
14	De-Morgan's Theorems- Write a program/ M-file to obtain the Truth Table to Prove De-Morgan's Theorems.	3
15	Seven segment Display- Write a program to solve the 7 Boolean expressions of Seven segment display to get the results in table form to indicate 'Display digit and segment LEDs on'.	3

	[To display the digit with 7 LEDs (light emitting diode) arranged as shown in Fig, the input D should be converted to 4-bit digit code and assigned to 7 Boolean functions to determine the on or off state of each diode in the 7-segment LED display]	
16	Transformers- Write a program to compute voltages of primary and secondary, primary current and secondary current. The inputs are kVA = 100, E1 = 230 kV, transformation ratio K = 0.6. Missing data may be assumed suitably.	3
17	DC Generators- Write a program to compute Emf generated in dc shunt generator with the given parameters like I_a= 10 A, I_L = 9 A, R_a = 0.5 Ω, Rsh= 120 Ω, and R_L= 6 Ω. Missing data may be assumed suitably.	3
	Total Duration (Hr.)	**51**

Reference Books:

For Pragramming:
1. Getting started with MATLAB by Rudra Pratap, Oxford University Press, 2005.
2. MATLAB and its Applications in Engineering by Rajkumar Bansal, Pearson Publishers, ISBN-10: 8131716813, 2009.
3. SCILAB(a Free Software to Matlab),Er. Hema Ramachandran and Dr. Achutsankar Nair, S. Chand Publishers, ISBN-10: 8121939704, 201.

For Electrical Engg. Basics:
4. Basic Electrical and Electronics Engineering by S. K. Bhattacharya, Pearson Education India, 2012 Edition.
5. A Text Book of Practicals in Electrical Engineering by Dr. N. K. Jain, DhanpatRai Publishing Company, 2009.

For Electronics Engg. Basics:
6. Electronics Laboratory Primer by S. Poornachandra and B. Sasikala, S. Chand Publishers and Co, 2010.
7. Laboratory Experiments and PSPICE Simulations in Analog Electronics by L.K.Maheshwari and M.M.S.Anand Publishers – PHI Learning Pvt. Ltd.
8. *Digital Electronics*: Principles and Applications by R. L. Tokheim, Tata McGraw-Hill Education, 2013.

Freely Available e-Resources/ e-Books:

1. http://in.mathworks.com/

2. https://www.scilab.org/resources/documentation/tutorials

3. Introduction to Programming with Matlab by J. Michael Fitzpatrick and John D. Crocetti, Department of Electrical Engineering and Computer Science, School of Engineering, Vanderbilt University, Nashville, TN, 2000-2011.

4. Introduction to Matlab: Application to Electrical Engineering by HoussemRafik El Hana Bouchekara, Umm El Qura University, Februray 2011.

5. A Matlab Tutorial by Dr. L. Doyle and Dr. A. Kokaram, Department of Electronic and Electrical Engineering, University of Dublin Trinity College, 2000.

6. Electronics and circuit analysis using MATLAB by John. O. Attia, Department of Electrical Engineering, Prairie View A&M University, Boca Raton London, New York, Washington D.C., CRC Press, 1999.

7. MATLAB for Electrical and Computer Engineering, Students and Professionals *with* Simulinkby Roland Priemer, University of Illinois at Chicago, Scitechpub.com, Edison, NJ, 2013.

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)
1	Remembering	20
2	Understanding	20
3	Application/ Analysis	60
Total		**100**

Mapping Course Outcomes with Program Outcomes:
(Course Outcome linkage to Cognitive Level)

	Course Outcome	Experiment linked	PO Mapped	Cognitive Level	Lab Sessions
CO1	Understand the main features and importance of the MATLAB/ SCI LAB mathematical programming environment.	Tutorial 1	2, 3, 4, 8, 9, 10	R/U/A	1
CO2	Apply working knowledge of MATLAB/ SCI LAB package to simulate and solve Electrical, Electronics circuits and Applications.	Tutorial 2 to 10	2, 3, 4, 8, 9, 10	U/A	15
CO3	Solve, Simulate and Analyse various DC circuits.	1,2,3,4,5	2, 3, 4, 8, 9, 10	U/A	15
CO4	Solve, Simulate and Analyse various AC circuits.	6,7,8	2, 3, 4, 8, 9, 10	U/A	9
CO5	Solve, Simulate and Analyse various Analog and Digital Electronics circuits.	9,10,11,12,13,14,15	2, 3, 4, 8, 9, 10	U/A	21
CO6	Solve, Simulate and Analyse simple Transformer and DC Generator circuits.	16, 17	2, 3, 4, 8, 9, 10	U/A	6

U-Understanding; A-Analysis; App-Application

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Circuit Simulation Lab	-	3	3	3	-	-	-	3	3	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 Delivery:

The laboratory Course will be delivered through Tutorial, Circuit equation solution, laboratory interaction, group discussion, practical exercises, instructions, assignments and viva voice.

Tutorial - 1Hr:

Staff-in-charge will;
1. Explain the concept and working of Circuit to be Simulated.
2. Give clear instructions about Analysing the Circuit and equations.
3. Impart/ discuss required selection of commands, instructions, functions, and sequence of program solution.
4. Ask students to write down the program/ M-file/ script file/ code to Simulate the given Circuit/ equations.

Conduction/ Execution- 2 Hr:

Student will write the program, execute and obtain the Circuit solution individually under the supervision of the staff-in-charge.

Course Assessment and Evaluation:

<table>
<tr><th colspan="2">What</th><th>To Whom</th><th>Frequency</th><th>Practical</th><th>Evidence Collected</th><th>Course Outcomes</th></tr>
<tr><td rowspan="5">Direct Assessment Method</td><td rowspan="4">CIE (Continuous Internal Evaluation)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">CIE (Continuous Internal Evaluation)</td><td>I A Tests</td><td rowspan="4">Students</td><td>Two IA tests for Practical (Average marks of both the tests)</td><td>10</td><td>Blue Books</td><td>1 to 6</td></tr>
</table>

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<tr>
<th colspan="2" rowspan="1">What</th>
<th>To Whom</th>
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<th>Practical</th>
<th>Evidence Collected</th>
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</tr>
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<td>I A Tests</td>
<td rowspan="4">Students</td>
<td>Two IA tests for Practical (Average marks of both the tests)</td>
<td>10</td>
<td>Blue Books</td>
<td>1 to 6</td>
</tr>
<tr>
<td>Record Writing</td>
<td>Record Writing (Average of Marks allotted for each experiment.)</td>
<td>10</td>
<td>Lab Record</td>
<td>1 to 6</td>
</tr>
<tr>
<td></td>
<td>Student Activity</td>
<td>05</td>
<td>3 pages Report</td>
<td>1 to 6</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td rowspan="1">SEE
(Semester End Examination)</td>
<td>End Exam</td>
<td>Students</td>
<td>End of the Course</td>
<td>50</td>
<td>Answer Scripts</td>
<td>1 to 6</td>
</tr>
<tr>
<td rowspan="2">Indirect Assessment Method</td>
<td colspan="1">Student Feedback on course</td>
<td rowspan="2">Students</td>
<td>Middle of The Course</td>
<td colspan="2">Feed Back Forms</td>
<td>1 to 3</td>
</tr>
<tr>
<td colspan="1">End of Course Survey</td>
<td>End of The Course</td>
<td colspan="2">Questionnaire</td>
<td>1 to 6</td>
</tr>
</table>

*__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.

Suggested Student Activity (any one to be submitted with 3 pages report):

1. Submit a report on MATLAB/ SCI Lab Engineering Applications, Features, Limitations, and Important Commands/ Instructions.
2. Solve, Analyze and Simulate BJT as a Switch.
3. Solve, Analyze and Simulate OP-AMP as Integrator.
4. Solve, Analyze and Simulate 3 bit Adder circuit.
5. Solve, Analyze and Simulate Transformer equivalent circuit.
6. Solve, Analyze and Simulate DC Generator Emf equation.

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimension	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks One activity on any one CO (course outcome) may be given to a group of FIVE students **Grand Average/Total**						14/4 =3.5 ≈4				

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Convensions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

Example only: MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY-Task given- Industrial visit and report writing
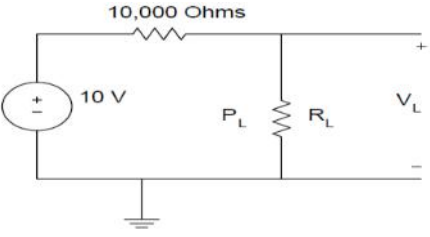
Scheme of Valuation for SEE(Semester End Examination):
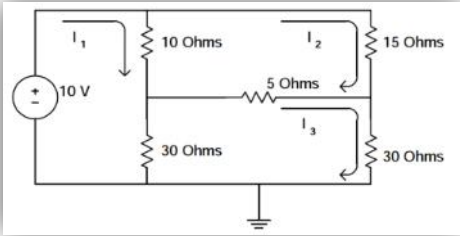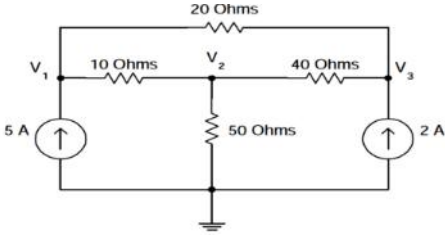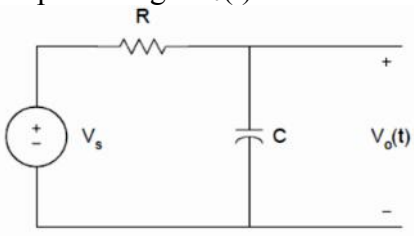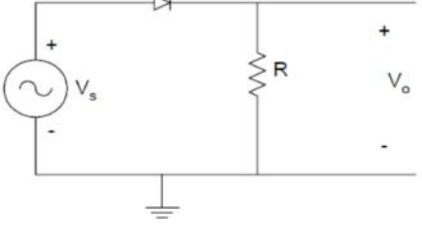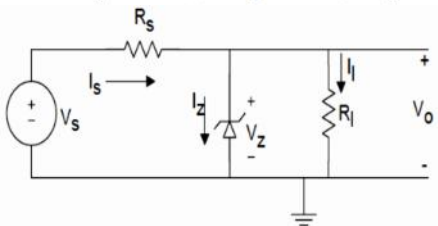
The SEE Question paper: One Question to be Answered.

Sl. No.	Particulars	Marks
1.	Circuit Solution (Key equations)	05
2.	Writing and Entering Program/ Code/ M-file/ Script file	20
3.	Errors Debugging	05
4.	Results	05
5.	Printout	05
6.	Viva-voce	10
	Total	**50**

Model Question Bank:
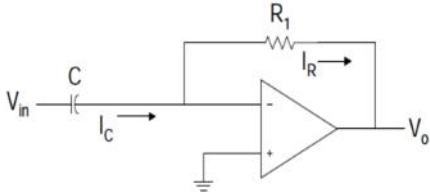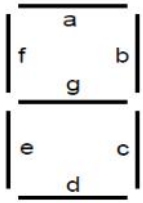
Course Title:**Circuits Simulation Lab**	Course Code: 15EE37P

Sl. No.	Question
1	Write a Program/ Simulate to generate a table of current, voltage and power dissipation. If R = 10 Ohms and the current is increased from 0 to 10 A with increments of 2A.
2	Write a Program/ Simulate to solve the equivalent resistance of series combination for three resistances R1, R2 and R3.
3	Write a Program/ Simulate to solve the equivalent resistance of parallel combination for three resistances R1, R2 and R3.
4	Solve and Simulate the given circuit using KVL by writing key equations and Program/ M-file to find the loop currents I_1, I_2 and I_3.
5	Solve and Simulate the given circuit using KCL by writing key equations and Program/ Code to find the nodal voltages V_1, V_2 and V_3.
6	Solve and Simulate Maximum Power Transfer condition for the given circuit when R_L varies from 0 to 50 k Ω. Also plot the power dissipated by the load and find Pmax. and value of R_L.

7	Simplify and Solve by writing Program for the following impedance z and express it both in rectangular and polar form. Also compute Admittance Y. $$z = \frac{(3+j4)(5+j2)(2\angle 60^0)}{(3+j6)(1+j2)}$$
8	Simulate the RL series circuit and plot a sketch of $v(t)$ and $i(t)$ for $t = 0$ to 20 milli seconds. The voltage $v(t)$ and current $i(t)$ are given as; $v(t) = 10\cos(377t)$ $i(t) = 5\cos(377t + 60^0)$
9	Simulate the given RC circuit, if the input voltage is a rectangular pulse with an amplitude of 5 Volts and a width of 0.5 sec. $C = 10$ μF and $R = 1000$ kΩ. Plot the output voltage $V_0(t)$ from zero seconds and end at 1.5 seconds.
10	Simulate the Half Wave Rectifier circuit and obtain the input and output plots. Assume suitable values for the ac source, circuit components and time frame.
11	Solve and Simulate the Zener Voltage Regulator with following data: $30 \le V_S \le 35V;$ $R_L = 10K,$ $R_S = 2K$ Obtain the Breakdown characteristics and calculate the output voltage Vs = 30 Volts and Vs = 35 Volts.

12	Solve and Simulate the given OPAMP Differentiator circuit. Assume suitable values for Input voltage and circuit components. Obtain the plots for OPAMP differentiator operation.
13	Solve and Calculate by writing Program/ Code for following Number System conversion. a). $(99)_{10} = (?)_2$ b). $(10011100)_2 = (?)_{10}$ c). $(6F9)_{16} = (?)_2$ and $(?)_{10}$
14	Simulate various Logic gates and obtain the results in Truth Table form. Demonstrate AND, OR, NAND, NOR, and EXOR operations. Take a and b inputs as 4 bits.
15	Simulate De-Morgan's Theorems and obtain results in Truth Table to Prove the above Theorems.
16	Simulate Seven segment Display. Obtain the results in table form to indicate 'Display digit and segment LEDs on'.
17	Solve and Simulate Transformer to compute voltages of primary and secondary, primary current and secondary current. Take kVA = 100, E1 = 230 kV, transformation ratio K = 0.6. Missing data may be assumed suitably.
18	Solve and Simulate DC Shunt Generator circuit to compute Emf generated with the given parameters like I_a= 10 A, I_L = 9 A, R_a = 0.5 Ω, Rsh= 120 Ω, and R_L= 6 Ω. Missing data may be assumed suitably.

Circuits Simulation Lab Equipments Requirement:

Students Intake   :   60
Students per Batch :   20

Sl. No.	Equipment Details	Specifications	Required Quantity
1	Personal Computers	Intel Core i5- 4th Generation- Processor, 3 GHZ, 4GB DDR3 RAM 1 TB Hard Disk DVD R/W Drive ATX Cabinet 19.5'' or 22 " LED Monitor Multimedia Keyboard 104 keys, Optical Mouse, Multimedia Speakers	20
2	Laser Jet Printers	Printer	5
3	LAN Switch for Networking	LAN Switch for Networking – 24port	5
3	UPS with Batteries	5 KVA UPS with Batteries 140 A-Hr,4 Hrs Backup	2
4	Software's	MATLAB or SCI Lab package	20
5	Air Conditioning System	1 Ton	2
6	LCD Projectors with Screen	With suitable Illumination Lumens	2