BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT

COURSEPLAN- 22UEE405C

Title of Course	:	**Power Systems - I**	**Course Code**	:	**22UEE405C**
Credits	:	**3**	**Contact Hours/ Week**	:	**3**
Total Hours	:	**40**	**Tutorial Hours**	:	**--**
CIE Marks	:	**50**	**SEE Marks**	:	**50**
Semester	:	**IV**	**Year**	:	**2023-2024**

Course Objectives:

	After completion of the course, students should be able
1	To list the mechanical components required for 3 phase transmission
2	To analyse overhead transmission line (short, medium & long) with respect to : voltage regulation and transmission efficiency
3	To draw single line diagram showing a typical distribution system
4	To list the fundamental requirements of protective relaying

Course Outcomes:

	At the end of the course the student should be able to:
1	**Select** various mechanical components for overhead transmission line based on the required electrical properties, mechanical properties and available budget.
2	**Estimate** sag for equal and unequal supports with and without considering wind and ice loading.
3	**Analyze** the performance of short, medium and long transmission lines.
4	**Select** relevant method to implement protective schemes against different faults in electrical systems.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Sl.	CO's \ PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
The students will be able to:																
1	22UEE505C.1	3											1	3		
2	22UEE505C.2	3	1										1	3	1	
3	22UEE505C.3	3	3	2	2	1	1						1	3	3	2
4	22UEE505C.4	3	3	3	3	1	1		1		1		2	3	3	3

Competencies Addressed in the course and Corresponding Performance Indicators

Programme Outcome: Any of 1 to 12 PO's:

PO	Competency		Performance Indicators	
1	1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply elements of electrical engineering principles and laws
	1.4	Demonstrate competence in Electrical engineering knowledge	1.4.1	Apply discipline specific laws and principles to solve an engineering problem
2	2.1	Demonstrate an ability to identify and characterize an engineering problem	2.1.1	Evaluate problem statements and Identify objectives
4	4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and importance
	4.3	Demonstrate an ability to critically analyze data to reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyse data
6	6.1	Demonstrate the ability to describe engineering roles in a broader context, e.g. as pertains to the environment, health, safety, and public welfare	6.1.1	identify and describe various engineering roles; particularly pertaining to protection of the public and public interest
9	9.2	Demonstrate effective individual & team operations -- communication, problem solving, resolution & leadership skills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL	PI addressed
	Unit -I			
1.	Students shall be able to list the advantages of high voltage transmission.	**1**	**1**	**1.3.1**
2.	Students shall be able to illustrate typical ac transmission system	**2**	**2**	**2.1.1**
3.	Students shall be able to identify components of overhead transmission line	**3**	**3**	**2.1.1**
4.	Students shall be able to calculate potential distribution over suspension insulator string	**3**	**3**	**6.1.1**
5.	Students shall be able to carry out calculation of sag for equal and unequal supports.	**3**	**3**	**2.1.1**
6.	Students shall be able to define basic terms associated with corona in transmission lines.	**1**	**1**	**1.4.1**
7.	Students shall be able to suggest type of insulators to be used based on various physical and technical parameters.	**4**	**4**	**9.2.1**
	Unit –II			
8.	Students shall be able to list constants of Transmission line	**1**	**1**	**1.3.1**
9.	Students shall be able to carry out calculation of Inductance of single phase two wire line	**3**	**3**	**2.1.1**
10.	Students shall be able to carry out calculation of Capacitance of single phase two wire line	**3**	**3**	**2.1.1**
11.	Students shall be able to list different types of overhead Transmission line	**2**	**2**	**1.4.1**
12.	Students shall be analyse short transmission line.	**2**	**2**	**4.1.1**
13.	Students shall be analyse various medium short transmission line	**2**	**2**	**4.1.1**
14.	Students shall be analyse long short transmission line by rigorous method.	**2**	**2**	**4.1.1**
15.	Students shall be able to calculate generalized circuit constants (ABCD) of a transmission line.	**3**	**3**	**6.1.1**
	Unit –III			
16.	Students shall be able to identify various parts of underground cable.	**2**	**2**	**2.1.1**
17.	Students shall be able to list Insulating materials for underground cables	**2**	**2**	**4.3.1**
18.	Students shall be able to list and explain methods of laying underground cable.	**3**	**3**	**1.4.1**
19.	Students shall be able to calculate Insulation resistance of single core cable	**3**	**3**	**6.1.1**

20.	Students shall be able to calculate capacitance of single core cable	**3**	**3**	**6.1.1**
21.	Students shall be able to calculate dielectric stress in a single core cable.	**3**	**3**	**6.1.1**
22.	Students shall be able to justify that dielectric stress is maximum at the conductor surface.	**4**	**4**	**4.3.1**
23.	students shall be able to compare the merits and demerits of underground system versus overhead system.	**3**	**3**	**6.1.1**
24.	Students shall be able to define and explain the terms: feeder, distributor and service means.	**2**	**2**	**1.3.1**
25.	Students shall be able to draw and explain single line diagram showing a typical distribution system.	**2**	**2**	**2.1.1**
26.	Students shall be able to list different types of DC distributors and their significance.	**2**	**2**	**4.1.1**
27.	Students shall be able to calculate voltage drop for a uniformly loaded distributor fed at one end.	**4**	**4**	**4.3.1**
	Unit –IV			
28.	Students shall be able to describe fundamental requirements of relaying	**2**	**2**	**1.4.1**
29.	Give the classification of protective relaying.	**2**	**2**	**2.1.1**
30.	Students shall be able describe arc phenomenon and principles of arc extinction	**2**	**2**	**4.1.1**
31.	Students shall be able to describe operation of oil & air blast breakers	**2**	**2**	**1.3.1**
32.	Students shall be able describe protection against over voltages.	**2**	**2**	**2.1.1**

Course Content:

Hours Required	Topic to be covered	Mode of Delivery
01	**AC Transmission Systems:** Typical AC transmission system, Advantages of high voltage transmission.	Chalk & talk
01	Comparison of conductor material in overhead lines: 3 phase 3 wire systems, 3 phase 4 wire system.	Chalk & talk
01	Components of overhead transmission line: Conductors, Line supports	Ppt,Chalk & talk
01	Insulators – Types	Ppt,Chalk & talk
01	Potential distribution over suspension insulator string, String efficiency,	Chalk & talk
01	Methods of improving string efficiency, Numericals	Chalk & talk
01	Corona – Factors affecting corona, Imp terms, Methods of reducing corona.	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	Sag in overhead lines- Calculation of sag for equal and unequal supports, Effect of wind and ice loading on sag.	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	**Electrical Parameters of Overhead Transmission Lines:** Constants of Transmission line. Inductance of single phase two wire line, Capacitance of single phase two wire line.	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	**Performance of Transmission Lines:** Classification of overhead Transmission line. Short Transmission line,	Chalk & talk
01	Medium Transmission line – End condenser method	Chalk & talk
01	Nominal T method	Chalk & talk

01	Nominal π method,	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	Long Transmission line – Rigorous Method	Chalk & talk
01	Generalized circuit constants (ABCD) of a transmission line.	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	**Underground Cables:** Construction of underground cables, Insulating materials for underground cables	Ppt,Chalk & talk
01	Laying of underground cables, Insulation resistance of single core cable,	Ppt,Chalk & talk
01	Capacitance of single core cable, Dielectric stress in a single core cable.	Ppt,Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	**Distribution Systems:** Classification of distribution systems. Overhead Vs Underground distribution system, Connection schemes of distribution system, Requirements of a distribution system	Ppt,Chalk & talk
01	Types of DC distributors, DC distributor fed at one end-Concentrated loading,	Chalk & talk
01	DC distributor fed at one end -Uniform loading, DC distributor fed at both ends - Concentrated loading	Chalk & talk
01	Numericals	Chalk & talk,Discussions
01	**Circuit Breakers:** Operating Principle of circuit breaking, Arc Phenomenon, Principle of Arc extinction,	Ppt,Chalk & talk
01	Methods of Arc extinction, Types of circuit breakers: Air blast circuit breaker, SF6 circuit breaker.	Ppt,Chalk & talk
01	**Protective Relaying and Protective Schemes:** Relay definition, Required qualities of Protective Relaying, Primary and Back up protection	Ppt,Chalk & talk
01	Classification of protective Relaying : Induction type Non-directional over current relay	Ppt,Chalk & talk
01	Directional relay	Ppt,Chalk & talk
01	Differential relay- Principle of operation	Ppt,Chalk & talk
01	Distance relays: Impedance Relay, Reactance Relay, Mho Relay	Ppt,Chalk & talk
01	Buchholz Relay	Ppt,Chalk & talk
01	**Static Relays:** Introduction, Basic construction and classification	Ppt,Chalk & talk
01	Definite time lag static over current relay, Inverse time static over current relay	Ppt,Chalk & talk
01	Static over voltage and under voltage relay	Ppt,Chalk & talk
01	Microprocessor based over current relay-block diagram approach	Ppt,Chalk & talk

Review Questions:

Review Questions	CO
What is electrical power supply scheme? Draw a single line diagram of a typical AC power supply scheme.	1
What are the advantages and disadvantages of DC transmission over AC transmission?	1
Discuss the advantages of high transmission voltage.	1
Compare the volume of conductor material required in three phase three wire and three phase four wire AC system.	2

Discuss the various conductor materials used for overhead lines what are their relative advantages and disadvantages.	**2**
Why are insulators used with overhead lines. Discuss the desirable properties of insulators.	**1**
What is strain insulator? Where is it used.	**1**
Give reasons for unequal potential distribution over a string of suspension insulators	**1**
Define and explain string efficiency. Can its value be equal to 100%	**1**
Show that in a string of suspension insulators the disc nearest to the conductor has the highest voltage across it.	**1**
Explain various methods of improving string efficiency.	**1**
What is corona what are the reasons which affect corona?	**1**
Discuss the advantages and disadvantages of corona.	**1**
Explain the following terms with reference to corona critical disruptive voltage visual critical voltage power loss due to corona.	**1**
What is sag in overhead transmission lines? discuss the advantages of providing too small or too large sack on a line	**2**
Derive an appropriate equation for sag in overhead lines when • supports are at equal levels • supports are at unequal levels	**2**
With the new diagram show the various parts of high voltage single core cable and explain	**1**
List the desirable characteristics of insulating materials used in underground cables	**1**
Describe briefly some commonly used insulating materials for underground cables	**1**
Describe the various methods of laying underground cables what are the relative advantages and disadvantages of each method	**1**
Derive an expression for insulation resistance of single core cable	**3**
Deduce an expression for capacitance of single core cable	**3**
Deduce an equation for maximum stress in single core cable	**3**
Prove that g_{max} / g_{min} in a single core table is equal to D/d.	**3**
Draw and explain single line diagram showing a typical distribution system.	**1**
Define and explain the terms: feeder, distributor and service means.	**1**
Discuss the relative merits and demerits of underground and overhead systems.	**1**
Explain the following systems of distribution • radial system • ring main system • interconnected system	**1**

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes/ Case Study/ Course Project/ Term Paper/Field Work	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS), BAGALKOT

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN

Title of Course	**:**	**Electrical Machines-II**	**Course Code**	**:**	**UEE407C**
Credits	**:**	**03**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**-**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**IV**	**Year**	**:**	**2024**

Prerequisites: Fundamental electrical concepts, including Ohm's Law, Kirchhoff's Laws, basic circuit analysis, and DC circuits. understanding of concepts like magnetic fields, Faraday's Law, Ampere's Law, and inductance. Proficiency in analysing AC & DC circuits, phasor analysis, and understanding of complex impedance. Basic physics knowledge, especially in the areas of mechanics and thermodynamics, may be beneficial for understanding the physical principles underlying electrical machines.

Course Objectives:

	The Course objectives are:
1	To understand the principle of operation of DC generators, motors and the concept of back emf.
2	To identify and discuss various applications of DC generators, motors, including the universal motor.
3	To implement speed control techniques for shunt field, separately excited, and series DC motors, including the Ward Leonard method.
4	To describe the construction and types of synchronous machines, along with the various types of field excitation. And To derive the EMF equation for synchronous generators and understand the effects of distribution winding and chorded coils.
5	To understand principles of parallel operation of alternators, synchronization, operation on an infinite bus, and the power flow equations of alternators. To discuss the operation of synchronous motors, including methods of starting, the effect of changing excitation, V and inverted V curves, hunting, and the role of damper windings.

Course Outcomes:

	At the end of the course the student should be able to:
1	Test the dc/ac generator and motor for losses and efficiency using various methods.
2	Analyse the effect of harmonics on ac generator and motor in emf generation.
3	Estimate the emf, number of poles/slots, losses, efficiency and power flow equations of dc/ac generator and motor
4	Select the suitable generator and motor for various engineering applications.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

S.No	Programme Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	22UEE407C.1	3				1	1						1	1	3	2
2	22UEE407C.2	3	1										1	1	2	1
3	22UEE407C.3	3	3	2	2								1		2	1
4	22UEE407C.4	3	3	3	3	1		1					2	1	2	1

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL
	Unit –I		
1.	Student shall be able to understand the constructional features of DC machines and identify the key components involved.	**03**	**1**
2.	Student shall be able to Explain the principles behind the generation of electromotive force (EMF) in DC generators and derive the EMF equation.	**03**	**1**
3.	Student shall be able to classify and describe different types of excitations used in DC generators, including separately excited and shunt field excitations.	**03**	**2**
4.	Student shall be able to analyze the no-load characteristics of separately excited and shunt field generators, including the relationship between terminal voltage and speed under varying load conditions.	**03**	**4**
5.	Student shall be able to investigate the load characteristics of separately excited and shunt field generators, focusing on the relationship between terminal voltage, armature current, and load torque.	**03**	**3**
6.	Student shall be able to evaluate the effects of armature reaction on the performance of DC generators, including demagnetizing and cross-magnetizing effects.	**03**	**2**
7.	Student shall be able to explain the role of compensating windings and interpole windings in minimizing armature reaction effects and improving commutation.	**03**	**2**
8.	Student shall be able to describe the process of commutation in DC generators and its significance in maintaining a constant output voltage.	**03**	**2**
9.	Student shall be able to understand the principle of operation of DC motors and explain the concept of back electromotive force (EMF) generated during motor operation.	**03**	**2**
10.	Student shall be able to derive the torque equation for DC motors and analyze the factors affecting motor torque production.	**03**	**4**
11.	Student shall be able to investigate the speed-torque characteristics of DC motors under varying load conditions and interpret the relationship between speed, torque, and armature current.	**03**	**4**
12.	Student shall be able to examine the applications of DC motors in various industrial and commercial settings, including their advantages and limitations.	**04**	**2**
13.	Student shall be able to describe the operation and characteristics of universal motors, highlighting their ability to operate on both AC and DC power sources.	**03**	**2**
	Unit –II		
14.	Student shall be able to understand the necessity of starters in DC motor applications and explain the purpose of various starting methods.	**01**	**2**
15.	Student shall be able to describe the principles behind resistance starters for DC motors and analyze their operation, excluding three-point and four-point starters.	**01**	**2**
16.	Student shall be able to explain the methods used for speed control of shunt field, separately excited, and series DC motors, including field weakening and armature voltage control techniques.	**01**	**2**
17.	Student shall be able to evaluate the Ward Leonard method of speed control and its applications in industrial settings, highlighting its advantages and limitations.	**01**	**5**

18.	Student shall be able to investigate the braking techniques employed for DC motors, including dynamic braking, regenerative braking, and plugging, and analyze their effectiveness under different operating conditions.	**01**	**5**
19.	Student shall be able to identify the different types of losses occurring in DC machines and calculate the efficiency of DC motors using loss analysis methods.	**01**	**4**
20.	Student shall be able to explain the principles behind direct load testing of DC motors and interpret the test results to determine motor performance characteristics.	**01**	**3**
21.	Student shall be able to describe Swinburne's test procedure for determining the efficiency of DC machines and analyze the test data to estimate motor parameters.	**01**	**2**
22.	Student shall be able to understand the Field's test method for determining the efficiency of DC series motors and its significance in practical motor testing scenarios.	**01**	**2**
23.	Student shall be able to compare the advantages and limitations of different testing methods for DC motors and select appropriate techniques based on specific testing requirements and motor characteristics.	**01**	**2**
	Unit-III		
24.	Student shall be able to describe the constructional features of synchronous machines and differentiate between different types such as cylindrical rotor and salient pole machines.	**03**	**4**
25.	Student shall be able to classify and explain various methods of field excitation including separately excited, self-excited, and permanent magnet.	**03**	**2**
26.	Student shall be able to derive and apply the EMF equation for synchronous generators, understanding its dependence on rotor speed and flux linkage.	**03**	**4**
27.	Student shall be able to analyze and explain the impact of distribution winding and chorded coils on machine performance, including effects on harmonics and induced EMF.	**03**	**2**
28.	Student shall be able to assess the influence of harmonics on the quality and magnitude of EMF generated by synchronous machines.	**03**	**3**
29.	Students will be proficient in constructing and interpreting phasor diagrams for cylindrical rotor synchronous generators, understanding the relationship between terminal voltage, load current, and excitation.	**03**	**2**
30.	Student shall be able to calculate and analyze voltage regulation in synchronous generators under varying load conditions, considering factors such as armature reaction and field excitation.	**03**	**3**
31.	Student shall be able to apply the EMF method to calculate synchronous reactance, understanding its significance in machine operation and performance evaluation.	**02**	**2**
32.	Student shall be able to comprehend the principles of salient pole synchronous machines, including the two-reaction model and the significance of saliency in machine design and operation.	**03**	**2**
33.	Student shall be able to conduct and interpret slip tests on synchronous machines to determine parameters such as synchronous reactance and efficiency, applying theoretical knowledge to practical scenarios.	**01**	**2**
	Unit-IV		
34.	Students will be able to explain the principles and techniques of synchronization for alternators, including the synchronization process and the significance of matching voltage, frequency, and phase sequence.	**02**	**2**
35.	Students will be able to describe and execute the parallel operation of alternators on a common bus, understanding load sharing, voltage regulation, and stability considerations.	**01**	**4**
36.	Students will be able to analyze the behavior of alternators operating on an infinite bus, including their response to load changes and frequency deviations, and will evaluate the implications for system stability.	**01**	**4**
37.	Students will be able to derive and utilize power flow equations for alternators operating in parallel, understanding the relationships between active and reactive power output and system parameters	**01**	**4**
38.	Students will be able to understand operating principles of synchronous motors, including the interaction between stator and rotor fields to produce synchronous rotation.	**01**	**2**

39.	Students will be able to evaluate various methods of starting synchronous motors, such as direct-on-line starting and soft starting, and will analyze their advantages, disadvantages, and applications.	**01**	**5**
40.	Students will be able to analyze V and inverted V curves of synchronous machines, understanding their significance in determining stable operating points, maximum power transfer, and field current limits.	**01**	**4**
41.	Students will be able to understand the role of damper windings in synchronous motors, understanding their function in damping oscillations and enhancing system stability during transient conditions.	**01**	**2**

Programme Outcomes with Respective Competencies & Performance Indicators

PO1: Engineering knowledge: **Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.**

	Competency	PI	Indicators
1.1	Demonstrate the competence in solving engineering mathematical problems	1.1.1	Apply fundamentals of mathematics to solve problems
		1.1.2	Apply advanced mathematical techniques to modelling and problem solving in electrical engineering
1.2	Demonstrate the competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply elements of electrical engineering principles and laws
1.4	Demonstrate competence in Electrical engineering knowledge	1.4.1	Apply discipline specific laws and principles to solve an engineering problem

PO2: Problem analysis: **Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.**

	Competency	PI	Indicators
2.1	Demonstrate an ability to identify and characterize an engineering problem	2.1.1	Evaluate problem statements and Identify objectives
		2.1.2	Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems.
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including justified approximations and assumptions
		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a system / model	2.3.1	Combine scientific and engineering principles to formulate models (mathematical or otherwise) of a system or process that isappropriate in terms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution, process and analyse results	2.4.1	Apply engineering mathematics and computations to solve (form & analyse) mathematical models.
		2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

PO3: Design/Development of Solutions: **Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.**

	Competency	PI	Indicators
3.1	Demonstrate an ability to define a complex open-ended problem in engineering terms	3.1.1	Recognize that good problem definition assists in the design process
		3.1.2	Elicit and document engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from a review of the State of the Art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
		3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
		3.2.2	Build models, prototypes, etc., to develop diverse set of design solutions
		3.2.3	Identify the suitable criteria for evaluation of alternate design solutions
3.3	Demonstrate an ability to select the optimal design scheme for further development	3.3.1	Apply formal multi-criteria decision making tools to select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generates information through appropriate tests to improve, or revise design states

PO4: Conduct investigations of complex problems: **Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.**

	Competency	PI	Indicators
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and importance
		4.1.2	Relate modern engineering experimentation including experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation, and/or software tools to make measurements of physical quantities
		4.1.4	Establish or validate a relationship between measured data and underlying physical principles.
4.2	Demonstrate an ability to design experiments to solve open ended problems	4.2.1	Develop and design experimental approach, specify appropriate equipment and procedures, implement these procedures, and interpret the resulting data to characterise an engineering material, component, or system.
		4.2.2	Understand the importance of statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to critically analyze data to reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyse data
		4.3.2	Critically analyse data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and draw conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions

PO5: Modern tool usage: **Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.**

	Competency	PI	Indicators
5.1	Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
		5.1.2	Create / adapt / modify / extend tools and techniques to solve problems
5.2	Demonstrate an ability to select and apply discipline specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulation, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using computing, mathematical, circuit simulation, and document presentation/preparation software. (MATLAB / Scilab, PSPICE, SABER, PROTEUS software tools, AutoCAD, project management tools, Latex and others)
5.3	Demonstrate an ability to evaluate the suitability and limitations of the tools used to solve an engineering problem	5.3.1	Identify limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

	Competency	PI	Indicators
6.1	Demonstrate the ability to describe engineering roles in a broader context, e.g. as pertains to the environment, health, safety, and public welfare	6.1.1	Identify and describe various engineering roles; particularly pertaining to protection of the public and public interest
6.1	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to electrical and electronics engineering discipline (such as IEEE) and explain its contribution to the protection of the public

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

	Competency	PI	Indicators
7.1	Demonstrate an understanding of the impact of engineering and industrial practice on social, environmental and economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Demonstrate an understanding of the relationship betweenthe technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevantto Electrical and Electronics Engineering

PO8: Ethics: Apply ethical principles and commit to professional ethics, responsibilities and norms of the engineering practice.

	Competency	PI	Indicators
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the IEEE professional code of ethics
		8.2.2	Examine and apply moral & ethical principles to historically famous case studies

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

	Competency	PI	Indicators
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity in a team
		9.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual & team operations -- communication, problem solving, resolution & leadership skills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
9.3	Demonstrate success in a team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

	Competency	PI	Indicators
10.1	Demonstrate an ability to comprehend technical literature and document project work.	10.1.1	Read, understand and interpret technical and non-technical information
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents
		10.1.3	Create *flow* in a document or presentation – a logical progression of ideas so that the main point is clear
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and view point of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

	Competency	PI	Indicators
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate and ability to Compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.2	Analyze and select the most appropriate proposal based on economic and financial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity withintime and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project so as to complete on time and within budget.

PO12: Life-long learning: **Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.**

	Competency	PI	Indicators
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale behind the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to bridge the same
12.2	Demonstrate an ability to Identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that require practitioners to seek education in order to stay updated
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep updated regarding new developments in the field
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Demonstrate an ability to source and comprehend technical literature and other credible sources of information

Course Content:

Day	Content	Mode of Delivery
1	Brief Introduction of the course, information regarding the course outcome of the course, program specific outcome and program outcome	Power Point Presentation, Chalk and talk in classroom
2	Construction details of DC machines and introduction of armature windings.	
3	Emf equation of the DC generator	
4	Excitation in DC Machines, Types of Excitation-Separately Excited, Series, Shunt type	
5	Armature reaction in DC generator and its effects on the machine	
6	Demagnetizing and Cross magnetizing AT/pole and numericals on it.	
7	Commutation in DC machine	
8	Compensating winding, Interpoles- functions and avantages	
9	No load and load characteristics of DC generator (Separately excited and Shunt excited)	
10	Principle of opeartion and concept of back emf	
11	Torque eqation and numericals on emf and torque	
12	Characteristics of DC motors, applicaions, Universal motor	
13	Explaination on necessity of starters, resistance starters	Power Point Presentation, Chalk and talk in classroom
14	Speed control methods of DC Motor	
15	Speed control of shunt field, separately excited and series motors.	
16	Ward Leonard method of speed control	
17	Explaination on braking of DC motor	
18	Different losses in DC machine and calculation of efficiency	
19	Explaination and understanding of direct load test, Swinburne's test	
20	Field's test on DC series motors	
21	Construction details of Synchronous machines and types of synchronous machines	Power Point Presentation, Chalk and talk in classroom
22	Types of field excitation in Synchronous machines	
23	Emf equation for synchronous generator	
24	Effect of distribution winding and chorded coils	
25	Effects of harmonics on emf generated in synchronous generator with cylindircal rotor	
26	Voltage regulation of synchronous generator	

27	Calculation of synchronous reactance by emf method	
28	Salient pole synchronous machine- Two reaction method	
29	Slip test on salient pole synchronous machine	
30	Numericals on Syncronous generator	
31	Understanding of Parallel operations of alternator	Power Point Presentation, Chalk and talk in classroom
32	Synchronization of alternators	
33	Alternator operation on infinite bus	
34	Operating characteristics of alternators	
35	Power flow equations of alternators	
36	Principle of operation of synchronous motors	
37	Methods of starting synchronous motors	
38	Synchronous motor phasor diagram, effects of changing excitation	
39	V and inverted V curves of synchronous machines	
40	Hunting in synchronous machines	
41	Effects of damper windings in synchronous machines	
42	Numericals on synchronous machines	

Review Questions:

Sl.	Review Questions	CO	BLL	PI
1	Draw the neat diagram and explain the main parts of DC machine	3	L2	1.3.1
2	Explain the commutation process in a DC Machine. What are the methods to improve the commutation?	3	L2	1.3.1
3	Explain the process of a lap connected 400 kW 6 pole DC generator are given a lead of 21 electrical degrees. Calculate the demagnetising and cross magnetising ampere turns. The full load current is 750 amps and number of armature conductors are 900.	2	L3	2.2.3
4	Explain the process of building up of voltage in a DC shunt generator. what are the conditions to be satisfied for voltage build up?	2	L2	1.3.1
5	Explain the different types of winding in DC machine	3	L2	1.3.1
6	A 25 kilowatt shunt generator is delivering full output of 400V bus bars and is driven at 950 rpm by belt drive. The belt breaks suddenly but the machine continues to run as a motor taking 25 kW from the bus bars. At what speed does it run? Given, R_a= 0.5Ω R is equal to 161	4	L3	2.2.3
7	With neat sketch explain the ward Leonard method of speed control of a DC motor. What are the advantages and disadvantages of this method over other methods?	4	L4	1.3.1
8	Draw and explain the different types of DC speed control of DC series motor	2	L2	1.3.1
9	A series motor having a resistance of 1 ohm between its terminals drives a fan. The torque of the fan is proportion to square of the speed. At 230 V its speed is 300 RPM and takes 15 A. The speed of the fan is to be increased to 375 RPM by increasing the voltage. Calculate the required voltage at this speed	2	L3	2.2.3
10	Classify different losses in a DC motor as fixed losses and variable losses and explain them. What is condition for maximum efficiency of motor?	1	L4	2.2.2
11	Explain different breaking systems of a DC motor with sketches and equations	2	L2	1.3.1
12	A full load break test on a DC shunt motor gave the following data Spring balance reading 25 kg and 9 kg Outside pulley diameter 19.5 CM Belt thickness 0.5 CM Motor speed 1500 RPM Applied voltage 230 volts Line current 12.5 A	3	L3	2.2.3

	Calculate the efficiency of the motor			
13	Draw and explain detail diagram of alternator stator and rotor diagrams for 3 phase, 4 pole and 3 slots/phase/pole. show the slots and conductors.	2	L2	1.3.1
14	A three phase, 16 pole synchronous generator has a resultant air gap flux of 0.06 Weber per pole. The data has two slots per pole per phase and 4 conductors per slot are accommodated in two layers. The coil Span is 150 electrical. Calculate the phase and line induced voltage when the machine runs at 375 RPM	2	L3	2.2.3
15	Define voltage regulation of a synchronous generator. Explain the parameters affecting the voltage regulation	2	L3	1.3.1
16	Draw the equivalent circuit of an alternator and derive the equation of armature induced emf	2	L3	1.3.1
17	A three phase 11 kV, star connected alternator delivers full load current of 80 A on short circuit by a field excitation of 2.8 A. An emf of 400 volt per phase is produced on open circuit by the same excitation. R= 0.7 ohm. Calculate voltage regulation at 0.8 leading and 0.75 legging pf.	1	L3	2.2.3
18	Explain the procedure of synchronisation	4	L2	1.3.1
19	What are the methods to start the synchronous motor? explain anyone	1	L2	1.3.1
20	Explain v and inverted V curves of synchronous motor	1	L2	1.3.1

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes/ Case Study/ Course Project/ Term Paper/Field Work	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

Details of Assignment:

Assignment	Marks (10)	CO	PI	CA	PO
Problem solving on DC machine EMF equation and finding the efficiency	2	01	1.1.2	1.1	1
Numerical problems on DC motors to find emf, efficiency, maximum torque, line current	2	02, 03	2.2.2	2.2	2
Surveying of different DC Motors, writing the application of new technology motors used in present days.	2	01,04	2.3.1		6
Quiz-1	4	01, 02, 03, 04	2.3.1	2.3	2

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOT

MODEL COURSE PLAN

Title of Course	:	**Control Systems**	**Course Code**	:	**22UEE408C**
Credits	:	**04**	**Contact Hours/ Week**	:	**04hrs/Week**
Total Hours	:	**52**	**Tutorial Hours**	:	**00**
CIE Marks	:	**50**	**SEE Marks**	:	**50**
Semester	:	**IV**	**Year**	:	**2023-24(EVEN)**

Prerequisites: Basic and advanced mathematics

Course Objectives:

Objective: To understand the concepts of the mathematical modelling, feedback control and stability analysis in time and frequency domains.

Course Outcomes:

	At the end of the course the student should be able to:
1	Classify control systems based on a number of ways and select them for particular applications.
2	Develop mathematical modeling of LTI control systems via differential equation formation, transfer function.
3	Employ time domain analysis to predict and diagnose transient performance parameters of LTI control systems for standard input function step.
4	Formulate different types of analysis in frequency domain to obtain the stability of the LTI control systems.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Sl. No.	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	21UEE408C.1	3	3	2	2	1							1	1	2	
2	21UEE408C.2	3	3	3	2	2							1	1	3	2
3	21UEE408C.3	3	3	2	2	2			1		1		1	1	3	2
4	21UEE408C.4	3	3	2	2	2			1		1		1	1	3	1

Competencies Addressed in the course and Corresponding Performance Indicators

Programme Outcome: Any of 1 to 12 PO's:

	Competency		Indicators
1.1	**Demonstrate the competence in solving engineering mathematical problems**	1.1.1	Apply fundamentals of mathematics to solve problems.
		1.1.2	Apply advanced mathematical techniques to modelling and problem solving in electrical engineering.
		1.4.1	Apply discipline specific laws and principles to solve an engineering problem.
1.2	**Demonstrate the competence in basic sciences**	1.2.1	Apply laws of natural science to an engineering problem.
1.3	**Demonstrate the competence in engineering fundamentals**	1.3.1	Apply elements of electrical engineering principles and laws.
2.1	**Demonstrate an ability to identify and characterize an engineering problem**	2.1.2	Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.4	**Demonstrate an ability to execute a solution, process and analyse results**	2.4.1	Apply engineering mathematics and computations to solve mathematical models.
3.1	**Demonstrate an ability to define a complex open-ended problem in engineering terms**	3.1.1	Recognize that good problem definition assists in design process.
4.1	**Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding**	4.1.2	Relate modern engineering experimentation including experiment design, system calibration, data acquisition, analysis and presentation.
5.1	**Demonstrate an ability to identify/create modern engineering tools, techniques**	5.1.1	Identify modern engineering tools, techniques and resources for engineering

	and resources.		activities.
5.2	**Demonstrate an ability to select and apply discipline specific tools, techniques and resources.**	5.2.2	Demonstrate proficiency in using computing, mathematical, circuit simulation, and document presentation/preparation software. (MATLAB/Scilab, PSPICE, and others).

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Content:

Sl.No.	Hours Required	Topic to be covered	Mode of Delivery
		Unit-I	
1	1L	Classification of control systems.	Chalk and talk in classroom/Lecture combined with discussions
2	1L	Open loop and closed loop systems, effects of feedback.	
3	1L	Discussion with examples on various types of control systems.	
4	1L	Introduction to MATLAB	
5	1L	Transfer function, Mathematical models of physical systems (Translational mechanical systems).	
6	1L	Mathematical models of physical systems (Rotational mechanical systems).	
7	1L	Exercises on mathematical modelling.	
8	1L	Exercises on mathematical modelling.	
9	1L	Force-Voltage analogy	
10	1L	Exercises on Force-Voltage analogy	
11	1L	Force-Current analogy.	
12	1L	Exercises on Force-Current analogy.	
13	1L	Usage of MATLAB commands	
		Unit-II	
14	1L	Introduction to block diagram, Block diagram reduction rules.	Chalk and talk in classroom/Lecture combined with discussions
15	1L	Exercises on block diagram reduction.	
16	1L	Introduction to SFG, Properties of SFG, Construction of SFG.	
17	1L	Mason's gain formula and its applications.	
18	1L	Exercises on SFG.	
19	1L	Standard test signals,	
20	1L	Unit step response of first order system.	
21	1L	Unit step response of second order system.	
22	1L	Exercises on time response of first and second order systems.	
23	1L	Steady state errors and constants.	
24	1L	Exercises on steady state errors and constants.	
25	1L	Exercises on steady state errors and constants.	
26	1L	Usage of MATLAB commands	
		Unit-III	
27	1L	Concept of stability	Chalk and talk in classroom/Lecture combined with
28	1L	R-H criterion.	
29	1L	Discussion on two difficulties in the formation of Routh	

		array.	discussions
30	1L	Exercises on R-H criterion.	
31	1L	Exercises on R-H criterion.	
32	1L	Stability analysis, R-H criterion.	
33	1L	Root locus and its construction	
34	1L	Root locus and its construction	
35	1L	Exercises on root locus.	
36	1L	Exercises on root locus.	
37	1L	Exercises on root locus.	
38	1L	Exercises on root locus.	
39	1L	Usage of MATLAB commands	
		Unit-IV	
40	1L	Introduction to frequency domain, frequency domain specifications, correlation between time and frequency response.	Chalk and talk in classroom/Lecture combined with discussions
41	1L	Bode plot and its construction.	
42	1L	Phase margin and gain margin.	
43	1L	Exercises on Bode plot.	
44	1L	Exercises on Bode plot.	
45	1L	Nyquist stability criterion.	
46	1L	Exercises on Nyquist stability criterion.	
47	1L	Exercises on Nyquist stability criterion.	
48	1L	State variable representation	
47	1L	Exercises on state variable representation	
48	1L	Conversion of state variable model to transfer function model.	
49	1L	Conversion of transfer function model to state variable model	
50	1L	Exercises on conversion of models.	
51	1L	Exercises on conversion of models.	
52	1L	Usage of MATLAB commands.	

Review Questions:

Sr.No.	Review Questions	ULO	BLL	PI addressed
1	What is control system?	**01**	**1**	**1.4.1**
2	Distinguish between open loop and closed loop control systems.	**01**	**2**	**1.4.1**
3	Define transfer function.	**01**	**1**	**1.4.1**
4	Name the basic elements of used for modeling mechanical system.	**01**	**1**	**1.4.1**
5	What is the basis for forming the rules of block diagram reduction techniques?	**01**	**2**	**1.4.1**
6	What is signal flow graph? What are its basic properties?	**01**	**1**	**1.4.1**
7	What are transient and steady state responses?	**01**	**1**	**1.4.1**
8	List time domain specifications.	**01**	**1**	**1.4.1**
9	Define steady state error.	**02**	**1**	**2.1.2**
10	What is frequency response?	**02**	**2**	**1.4.1**

11	List frequency domain specifications.	**02**	**1**	**1.4.1**
12	Define gain margin and phase margin.	**02**	**2**	**2.1.2**
13	Define stability.	**02**	**1**	**1.4.1**
14	What is the relationship between stability and coefficients of characteristic polynomial?	**02**	**03**	**1.4.1**
15	What is the principle of argument?	**02**	**02**	**1.4.1**
16	State Routh Nyquist stability criterion.	**02**	**03**	**1.4.1**
17	What are the main significances of root locus?	**03**	**01**	**1.4.1**
18	Routh stability criterion.	**03**	**03**	**1.4.1**
19	Define state space.	**03**	**02**	**1.4.1**
20	What are the advantages of state space techniques?	**03**	**03**	**1.4.1**

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes/ Case Study/ Course Project/ Term Paper/Field Work	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

Details of Assignment Quiz:

Assignment Quiz	Marks (10)	CO	PI	CA	PO
		1,2,3,4	**1.4.1, 2.1.2**	**1.1,2.1, 2.2, 2.4**	**1,2,3,4**