



**Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore**  
**Shri Vaishnav Institute of Technology and Science**  
**Choice Based Credit System (CBCS) in the Light of NEP-2020**  
**B.Tech. in Electrical Engineering**  
**(Common to EE\EX)**  
**(2021-2025)**

COURSE CODE	CATEG ORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
<b>BTEE 501</b>	<b>DCC</b>	<b>Electrical Machines-II</b>	60	20	20	0	0	3	0	2	4

**Legends:** L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit.

\***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

**Course Educational Objectives (CEOs):**

To prepare the students to have a basic and practical knowledge of DC machine. To prepare the students to have a basic knowledge of 3 phase Synchronous machine.

**Course Outcomes (COs):**

Upon completion of this course students will be able to:

1. Demonstrate various parts of an electrical machine.
2. Conduct Different test on DC machine.
3. Understand and analyze synchronous generator.
4. Demonstrate constructional details, principle of operation of Special Machines.

**Syllabus**

**UNIT I**

[8 Hrs]

**DC Generators:** Introduction, construction, types, emf equation, lap and wave windings, armature reaction, commutation, methods of improving commutation, equalizer rings, demagnetizing and cross magnetizing ampere turns, various characteristics of shunt, series and compound generators, voltage build up, losses and efficiency, condition for maximum efficiency.

**UNIT II**

[8 Hrs]

**DC Motors:** Introduction, principals, back-emf, torque of motor, types, characteristics of shunt, series and compound motors, speed control (field and armature control methods), basic idea of solid state devices in controlling of DC motors, Starting of DC motors, three point and four point starters, losses and efficiency, testing (brake test, swimburnes, hopkinson test), Applications.

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**UNIT III**

[9 Hrs]

**Synchronous Generators (Alternators):** Introduction, Construction, advantages of rotating field, types of rotors, emf equation, excitation systems, equivalent circuit and their phasor diagrams, voltage regulation, synchronous impedance method, mmf method.

Zero power factor method, two reaction theory of salient pole rotor, phasor diagram, power developed and power angle characteristics of salient pole machine, determination of  $X_d$  and  $X_q$ , synchronization, synchronizing power and torque, parallel operation application.

**UNIT IV**

[8 Hrs]

**Synchronous Motors:** Introduction, construction, principal of operation, starting of synchronous motor, equivalent circuit and phasor diagrams, power and torque, performance calculation, speed torque characteristics, power factor control-effect of change of excitation.

**UNIT V**

[7 Hrs]

**Synchronous Motors:** V curve and inverted V curve, synchronous condenser and reactors, synchronous phase modifiers, hunting-causes and remedies, applications, synchronous induction motor application.

**Textbooks:**

1. A. E. Fitzgerald, C. Kingsley Jr and Umans, Electric Machinery, 6th Edition McGraw Hill, International Student Edition.
2. I.J. Nagrath & D.P. Kothari, Electric Machines, 3/e, Tata McGraw Hill, New Delhi.

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**References:**

1. M.G. Say, Performance & design of AC machines, CBS publishers & distributors, Delhi, 3rd edition
2. P.S. Bhimbra, Generalized theory of Electrical Machines, Khanna publishers, Delhi,
3. Ashfaq Husain, Electric Machines, DhanpatRai, New Delhi.
4. Syed A. Nasar, Electric Machines & Power Systems, Volume I, Tata McGraw Hill, New Delhi
5. Stephen J Chapman, Electric Machinery Fundamentals, McGraw-Hill

**List of Experiments:** Experiments can cover any of the above topics, following is a suggestive list:

1. To obtain open circuit characteristics of self excited DC shunt generator and to find its critical resistance.
2. Speed control of D.C. shunt motor by Field current control method & plot the curve for speed verses field current.
3. Speed control of D.C. shunt motor by Armature voltage control method & plot the curve for speed verses armature voltage.
4. To perform Swinburne's test on a DC shunt machine and to calculate efficiency at full load.
5. To perform Hopkinson's test on a DC shunt machine and to calculate full load efficiency (a) when running as motor and (b) when running as generator.
6. Draw & verify open circuit characteristics of 3- $\phi$  synchronous generator.
7. Draw & verify short circuit characteristics of 3- $\phi$  synchronous generator.
8. Draw & verify external load characteristics of 3- $\phi$  synchronous generator.
9. Calculate  $X_d$  &  $X_q$  parameter of synchronous machine by slip test.
10. Synchronization of a three-phase alternator with the infinite bus and control load sharing.
11. Draw & verify 'V' curve of 3- $\phi$  synchronous motor.

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<b>BTEE502</b>	<b>DCC</b>	<b>POWER ELECTRONICS</b>	60	20	20	30	50	2	1	2	4

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**Course Educational Objectives (CEOs):**

This course aims to equip the students with a basic understanding of modern power semiconductor devices, various important topologies of power converter circuits for specific types of applications. The course also equips students with an ability to understand and analyze non-linear circuits involving power electronic converters.

**Course Outcomes (COs):**

Upon completion of the course, the student will be able to

1. Understand the principle of operation of commonly employed power electronic converters.
2. Analyze non-linear circuits with several power electronic switches.
3. Equipped to take up advanced courses in Power Electronics and its application areas.

**Syllabus**

**UNIT-I**

**9 Hrs.**

Power Semiconductor diodes and Transistors: Types of power diodes-General purpose diodes-Fast recovery diodes- Their characteristics and applications, Bipolar junction transistors, Power MOSFETS P-Channel, N-Channel, IGBTs- Basic Structure and working, Steady state and switching characteristics-Comparison of BJT, MOSFET and IGBT-Their applications.

**UNIT-II**

**10 Hrs.**

Principle of operation of SCR, Static and dynamic characteristics-Two transistor analogy, condition of turn on & off of SCR, Gate characteristics, GTO, DIAC, TRIAC, UJT, IGCT Characteristics.

Trigger circuits-R, RC and UJT triggering circuits. Various commutation methods of SCRs, Protection of SCRs, Series and Parallel operation of SCRs, String efficiency.

**UNIT-III**

**9 Hrs.**

AC-DC Converter: Principles of controlled rectification—Study of single phase and three phase half controlled and full controlled bridge rectifiers with R, RL, RLE loads Effect of source inductances. Dual Converters—circulating current mode and Non-circulating current mode, Control Strategies.

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**UNIT-IV**

**9 Hrs.**

DC-DC Converter: Classification of Choppers: A, B, C, D & E, Jones and Morgens chopper. Switching mode regulators - Study of Buck, Boost, Buck-Boost regulators.

AC-AC Converter: Principle of operation of Single Phase Bridge type cyclo-converters and their applications. Single phase and Three phase AC Voltage controllers with R & RL load.

**UNIT-V**

**9 Hrs.**

DC-AC Converter: Principle of operation of Single Phase Inverters-Three phase bridge inverters (180 and 120 Degree modes)-voltage control of invertors—Single Pulse Width Modulation-Multiple pulse width Modulation-Sinusoidal Pulse Width Modulation .Comparison of Voltage Source Inverter and Current Source Inverters.

**Textbooks:**

1. Rashid, M.H, 'Power Electronics - Circuits, Devices and Applications', Prentice Hall Publications, 3 rd Edition, 2003.
2. M.D.Singh and K.B.Kanchandhani, 'Power Electronics', Tata McGraw-Hill Publishing Company Limited, 2nd Edition, 2006.

**References:**

1. Ned Mohan, Tore M. Undeland, William P. Robbins, 'Power Electronics', John Wiley & Sons Publications, 3rd Edition, 2006.
2. Vedam Subramaniam, 'Power Electronics', New Age International (P) Ltd Publishers, 2001.
3. Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, 1st Edition, 2012.
4. V. R. Moorthi, 'Power Electronics- Devices, Circuits and Industrial Applications', Oxford University Press, 1st Edition, 2005. 4. P.S. Bimbhra, 'Power Electronics', Khanna Publishers, 3rd Edition, 13th Reprint, 2004

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**List of Experiments:**

1. Show Static and dynamic characteristics of an SCR.
2. Examine Static and dynamic characteristics of TRIAC.
3. Examine Static and dynamic characteristics of DAIC.
4. Determine Characteristics of MOSFET and IGBT.
5. Analyze Single phase SCR Half controlled converter with R and RL load.
6. Analyze Single phase fully controlled (bridge) converter with R and RL load.
7. Design 3-phase SCR Half Controlled Converter (using simulation platform like MATLAB/Simulink)
8. Design of 3-phase SCR Fully Controlled Converter (using simulation platform like MATLAB /Simulink)
9. Recall of classes of commutation A, B, C, D, E, F.
10. Simulation of Chopper circuit using SCR.

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BTEE503	DCC	Control System Engineering	60	20	20	30	20	2	1	2	4

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**Course Educational Objectives (CEOs):**

The course will provide understanding of control system and mathematical modeling of the system

**Course Outcomes (COs):**

After the successful completion of this course students will be able to

1. Demonstrate the understanding of basic element and modeling of the control system.
2. Analyze the stability in time domain and frequency domain
3. Design the controller and compensators for the system

**Syllabus**

**UNIT I**

**8 Hrs**

**Introduction:** Basic Elements of Control System, Open loop and \*Closed loop systems, Differential equation, Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph, Constructional and working concept of ac servomotor.

**UNIT II**

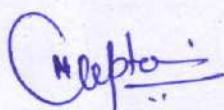
**9 Hrs**

**Time Domain Analysis:** Standard test signals, Time response of first order systems, Characteristic Equation of Feedback control systems, Transient response of second order systems, Time domain specifications, Steady state response, Steady state errors and error constants, P, PI, PD and PID Compensation

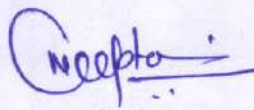
**UNIT III**

**8 Hrs**

**Stability Analysis and Root locus:** The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability. The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.



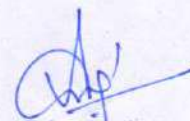
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#### UNIT IV

**8 Hrs**

**Frequency domain Analysis:** Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and Phase margin and Gain margin-Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots, Stability analysis. Compensation techniques – Lag, Lead, Lead-Lag Controllers design in frequency Domain

#### UNIT V

**8 Hrs**

**State Space Analysis of Continuous Systems:** Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

#### Textbooks:

1. I.J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 7th Edition, 2021.
2. Richard C Dorf; Robert H Bishop, "Modern control system", Pearson Education, 13th Edition, 2017.

#### References:

1. M F Golnaraghi and Benjamin C Kuo, "Automatic control systems", New York McGraw-Hill Education, 9th Edition, 2017.
2. M.Gopal, Digital Control and State Variable Methods, Tata McGraw- Hill 4th Edition, 2014.
3. Joseph J DiStefano, Allen R Stubberud and Ivan J Williams, Schaum's Outline Series, "Feedback and Control Systems", Tata McGraw- Hill, 2nd Edition 2014.
4. John J.D'azzo & Constantine H.Houpis, 'Linear control system analysis and design', Tata McGraw-Hill., 8th Edition.

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**List of Experiments:**

1. Perform step response of a transfer function
2. Perform impulse response of a transfer function
3. Perform ramp response of a transfer function
4. Analyze torque speed characteristics and determine the transfer function of a DC servomotor.
5. Analyze characteristics of a small AC servomotor and determine its transfer function.
6. Perform the transient and frequency response of a second order network.
7. Perform the performance of various types of controllers used to control the temperature of an oven.
8. Draw nyquist plot from a transfer function
9. Draw root locus from a transfer function
10. Draw bode plot from a transfer function

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BTEE504	DCC	Switchgear and Protection	60	20	20	30	20	2	1	2	4

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**Course Educational Objectives (CEOs):**

To introduce the students the different types of faults, circuit breakers and protective relays for protecting power system equipments.

**Course Outcomes (COs):**

After the successful completion of this course students will be able to

1. Gain knowledge on protective relays and circuit breakers.
2. Understand the concept of protection of generators, transformers, and bus bars.
3. Gain knowledge in different types of microprocessor-based relays.
4. Understand the concept of lightning and its protection.

**Syllabus**

**UNIT I**

**8 Hrs.**

**Fault Analysis:** Faults in power systems (Symmetrical & Unsymmetrical), Fault analysis in per unit System, representation of power system as Single line and equivalent impedance diagram. Symmetrical components and its application to power systems, Sequence networks and their interconnection for different types of faults, Effect of fault impedance, Current limiting reactors, its location and application, short circuit calculation.

**UNIT II**

**9 Hrs.**

**Protective Relays:** Requirement of relays, Primary & backup protection, Desirable qualities of relays, Concept of Pickup, reset & drop-off, Drop off/ Pickup ratio, inverse time & definite time characteristics. Types of Relays: Attracted armature, Balanced Beam, Induction disc, Induction cup, moving coil & moving Iron, Rectifier, Thermal, Bimetal directional relay, Frequency, DC, all or nothing relays, Pilot & negative sequence, over current, Over Voltage, Directional, Differential and Distance relays, R-X diagram, Impedance mho & reactance relay. Introduction of static analog & digital relays. Thermal Imaging- Types, Fault Detection on transmission lines using thermal imaging, Applications.

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### UNIT III

**9 Hrs.**

Circuit Breakers

Elementary principle of arc quenching, recovery & re-striking voltage, arc quenching devices, description and operation of Bulk oil, Minimum oil, Air break, Air blast, SF<sub>6</sub>, Vacuum circuit breakers and DC circuit breakers, their comparative merits, LT Switch gear, HRC fuses, current limiting reactor & influence of reactors in CB ratings, Testing of circuit breaker.

### UNIT IV

**9 Hrs.**

System Protection

Protection of Generators -Earth Fault, percentage. differential. Loss of excitation, Prime mover failure, Over current, Turn to turn fault, Negative phase sequence, heating, Reverse power protection schemes Protection of Transformers Internal & external fault protection, Differential, Earth fault, Over Current, Overheating, Protection schemes, Protection of transmission lines, Over current, Distance and carrier current protection schemes.

### UNIT V

**9 Hrs.**

Surge Protection & insulation co-ordination

Switching surges, Phenomena of Lightning, over voltage due to lightning, Protection against lightning, Lightning arrestors, selection of lightning arrestors, Surge absorbers and diverters, Rod gap, Horn gap expulsion type & valve type lightning arrestors, solid resistance and reactance earthing, Arc suppression coil, Earthing transformers, Earth wires, Earthing of appliances, insulation co-ordination.

### Textbooks:

1. Switchgear & protection, by Sunil S. Rao. Khanna Publication, 14<sup>th</sup> edition, 2019.
2. Electrical Power systems, by CL Wadhwa, New age International, 8<sup>th</sup> edition, 2022.

### References:

1. B. Ravindran and M Chander, Power System protection and Switchgear, New Age International, 2<sup>nd</sup> edition, 2018.

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**B.Tech. in Electrical Engineering**  
**(Common to EE\EX)**  
**(2021-2025)**

COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTEE504	DCC	Switchgear and Protection	60	20	20	30	20	2	1	2	4

**Legends:** L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit.

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**List of Experiments:**

1. Determination of drop out factor of an instantaneous over current relay.
2. Determination of operating characteristic of IDMT relay.
3. Determination of operating characteristic of differential relay.
4. Study and operation of gas actuated protective relay.
5. Study and operation of static over current relay.
6. Determination of transmission line parameters using MATLAB.
7. Analysis of power system faults (Symmetrical & Asymmetrical) using MATLAB.
8. Study of SF6 circuit breaker
9. Simulation of protection of generator and Transformer.
10. Simulation of protection of Feeder & Motor protection.

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**(2021-2025)**

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTEE514	DE	<b>Introduction of IoT in Electrical Engineering</b>	60	20	20	0	0	3	0	0	3

**Legends:** L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit.

\***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

**Course Educational Objectives (CEOs):** The objective of study of IoT in Electrical Engineering is to:

1. Study IoT characteristics and definition
2. Study various IoT Sensors and communication technology
3. Study physical devices and endpoints
4. Study applications of IoT in electrical Engineering

**Course Outcomes (COs):**

After the successful completion of this course students will be able to

1. Attain knowledge of IoT in Electrical Engineering
2. Attain knowledge on IoT sensors and devices
3. Attain knowledge on internet connectivity of IoT
4. Learn application of IoT in various domain.

### Syllabus

#### UNIT I

7Hrs.

##### Introduction to IoT

Introduction: Definition and characteristics of IoT, Physical design of IoT, Logical Design of IoT, IoT enabling technologies, IoT levels and deployment templates.

#### UNIT II

8 Hrs.

##### IoT/M2M and Internet Connectivity

M2M, difference between IoT and M2M, Introduction to internet connectivity, Internet connectivity principles, Internet based communication, IP addressing in the IoT, Media access control, Application layer Protocols: HTTP, HTTPS, FTP, Telnet, and others.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
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**UNIT III**

**8 Hrs.**

**IoT physical devices and End points**

Basic building blocks of an IoT devices, raspberry pi, Raspberry pi interfaces, other IOT interfaces.

**UNIT IV**

**8 Hrs.**

**Sensors**

Introduction, sensor Technology, participatory sensing, Industrial IoT and Automotive IoT, Actuator, sensor data communication Protocols, Radio frequency identification Technology, wireless sensor Network technology

**UNIT V**

**8 Hrs.**

**Application of IoT in Smart Grid And Other Domains**

Generation, Transmission, Distribution and Metering, Energy Storage, Smart Monitoring and Diagnostics System at Major Power Plants, Real-Time Monitoring and Control of Processes, SCADA, Proprietary Communication, Home automation, Building automation, IoT application in environment, cities, agriculture, industry

**Textbooks:**

1. George Mastorakis , (2016), Internet of Things (IoT) in 5G Mobile Technologies, 1st ed. Edition, Publisher SPRINGER.
2. ArshdeepBahga, Vijay Madiseti (2016) Internet of Things-A hands on approach, 1<sup>st</sup> Edition, Universities Press
3. Raj Kamal (2017), Internet of Things-Architecture and design principles, 1st Edition, Mc Graw Hill Education

**References:**

1. Enterprise IoT: Strategies and Best Practices for Connected Products and Services, Dirk Slama, Frank Puhlmann, Jim Morrish, Rishi M Bhatnagar, Publisher O'REILLY

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTMES10	AESE	DESIGN THINKING AND INNOVATION	60	20	20	0	0	2	0	0	2

**Legends:** L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

\***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

**Course Educational Objectives (CEOs):**

The objective of this course is to provide (A) the new ways of creative thinking and learn the innovation cycle of design thinking process, (B) understand product design and prototyping and (C) develop innovative product.

**Course Outcomes (COs):**

After completion of this course student will able to

1. Compare and classify the various learning styles and memory techniques and apply them in their engineering education
2. Analyze emotional experience and inspect emotional expressions to better understand users while designing innovative products
3. Develop new ways of creative thinking and learn the innovation cycle of design thinking process for developing innovative products
4. Propose real-time innovative engineering product designs and choose appropriate frameworks, strategies, techniques during prototype development
5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

**Syllabus**

**Unit I**

**(6 Hrs)**

Learning: understanding the learning process, Kolb's learning styles, assessing and interpreting.

Memory: understanding the memory process, problems in retention, memory enhancement techniques.

Emotions: understanding emotions, experience & expression, assessing empathy, application with peers.

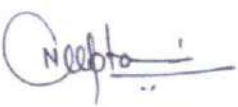
**Unit II**


**(6 Hrs)**

Design Thinking: definition, need, objective, concepts & brainstorming, stages of design thinking process (explain with examples) – **empathize, define, ideate, prototype, test.**

Creative Thinking: understanding creative thinking process, understanding problem solving, creative problem solving test.

  
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BTME510	AESE	DESIGN THINKING AND INNOVATION	60	20	20	0	0	2	0	0	2

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

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**Unit III**

**(6 Hrs)**

Product Design: process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design.  
 Prototyping: What is prototype? Why prototype? Rapid prototype development process, testing, sample example, test group marketing

**Unit IV**

**(6 Hrs)**

Celebrating the Difference: understanding individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual differences  
 Customer Centricity: practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

**Unit V**

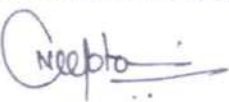
**(6 Hrs)**

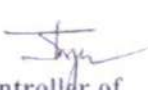
Feedback, Re-design & Re-create: feedback loop, focus on user experience, address “ergonomic challenges, user focused design, rapid prototyping & testing, final product, final presentation – “solving practical engineering problem through innovative product design & creative solution”.


**Text and Reference Books:**

1. E. Balaguruswamy “Developing Thinking Skills (The way to Success)” Khanna Book Publishing Company, 2022.
2. Gavin Ambrose and Paul Harris “Basics Design 08: Design Thinking” Bloomsbury Publishing India Pvt. Ltd. 2009.
3. Vijay Kumar “101 Design Methods: A Structured Approach for Driving Innovation in Your Organization” Wiley Pub. 2012.
4. Idris Mootee, “Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School”, John Wiley & Sons 2013.
5. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), “Design Thinking: Understand – Improve – Apply”; Springer, 2011
6. Roger Martin, “The Design of Business: Why Design Thinking is the Next Competitive Advantage”. Harvard Business Press, 2009.

  
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