PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING

1186A, SHIVAJINAGAR, OFF J.M, PUNE-411005

(AFFILIATED TO SAVITRIBAI PHULE PUNE UNIVERSIT, PUNE)

DEPARTMENT OF ELECTRICAL ENGINEERING

E-CURRICULUM BOOKLET

(2019 Course)

FOR THE PROGRAMME

SE – ELECTRICAL ENGINEERING

(SEMISTER-I)

QUALITY POLICY OF THE INSTITUTE

We, PES Modern College of Engineering are committed to develop and foster cultured and promising professionals by imparting quality education in the field of Engineering and Management.

VISION OF THE INSTITUTION

To create a collaborative academic environment to foster professional excellence and ethical values

MISSION OF THE INSTITUTE

1. **To develop outstanding engineers & professionals with high ethical standards capable of creating and managing global enterprises.**
2. **To foster innovation and research by providing a stimulating learning environment.**
3. **To ensure equitable development of students of all ability levels and backgrounds.**
4. **To be responsive to changes in technology, socio-economic levels and environmental conditions.**
5. **To foster and maintain mutually beneficial partnerships with alumni and industry.**

QUALITY POLICY OF THE DEPARTMENT

Electrical Engineering department is committed to develop promising engineers with ethical and social responsibility through excellence in academics, research, skill development and consultancy.

VISION OF THE DEPARTMENT

To build technically competent Electrical Engineers with ethical and social responsibility.

MISSION OF THE DEPARTMENT

- **To develop abilities in students for acquiring knowledge and skills to flourish in dynamic technical environment.**
- **To nurture cultured professionals by providing facilities for their overall development.**
- **To motivate the students for research work and activities beneficial to society.**
- **To enhance strong bonding with various organization and alumni.**

Program Educational Objectives (PEOs)

Graduates will be able to:

PEO 1: Solve and analyze problems in Electrical Engineering using fundamental knowledge.

PEO 2: Adopt lifelong learning ability by acquiring various skills.

PEO 3: Practice ethically in their profession.

PEO 4: Achieve global competency through interactions with various industries, research and professional organizations.

PROGRAM OUTCOMES (POs)

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, research literature, and analyses 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: The problems that cannot be solved by straight forward application of knowledge, theories and technique applicable to the engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (Like: cost, power requirement, durability, product life, etc.). Which need to be defined (modeled) within appropriate mathematical framework that often requires use of modern computational concepts and tools.

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.

PROGRAM SPECIFIC OUTCOMES:

PSO1: Students will be able to apply logical and technical concepts of automation, control syste and electric mobility.

PSO2: Students will be able to develop adequate competency in electrical energy manageme through conventional and non-conventional energy sources.

CORE VALUES

- Excellence in the field of Electrical Engineering.
- Social responsibility with integrity.
- Lifelong Learning.
- Unity in Diversity.

SHORT TERM GOALS

- To enhance alumni interaction.
- To develop innovation lab to enhance research and entrepreneurship by providing various facilities.

LONG TERM GOALS

- To promote consultancy activity for revenue generation by developing high-tech standard laboratory.
- To encourage the faculty for research work and up gradation of qualifications.
- To enhance teaching-learning process through ICT.
- To establish competitive entrance exam cell in department.

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Course Structure

Savitribai Phule Pune University

Syllabus: Second Year (SE) Electrical Engineering (2019 Course) w.e.f. AY:2020-2021

SEMESTER-I

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
207006	Engineering Mathematics-III	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203141	Power Generation Technologies	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203142	Material Science	03	04#	--	30	70	25	--	25	**150**	03	02	--	**05**
203143	Analog and Digital Electronics	03	02	--	30	70	--	50	--	**150**	03	01	--	**04**
203144	Electrical Measurement & Instrumentation	03	04#	--	30	70	25	25	--	**150**	03	02	--	**05**
203150	Applications of Mathematics in Electrical Engineering	--	02*	--	--	--	25	--	--	**25**	--	01	--	**01**
203151	Soft Skill	--	02	--	--	--	25	--	--	**25**	--	01	--	**01**
203152	Audit Course-III	--	--	--	--	--	--	--	--	--	**Grade: PP/NP**			
Total		**15**	**14**	--	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**07**	--	**22**

SEMESTER-II

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
203145	Power System-I	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203146	Electrical Machines-I	03	02	--	30	70	--	50	--	**150**	03	01	--	**04**
203147	Network Analysis	03	02	--	30	70	25	--	--	**125**	03	01	--	**04**
203148	Numerical Methods & Computer Programming	03	02	--	30	70	--	25	--	**125**	03	01	--	**04**
203149	Fundamental of Microcontroller and Applications	03	04$	--	30	70	25	--	25	**150**	03	02	--	**05**
203152	Project Based Learning	--	04	--	--	--	50	--	--	--	--	02	--	--
203153	Audit Course-IV	--	--	--	--	--	--	--	--	--	**Grade: PP/NP**			
Total		**15**	**14**	--	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**07**	--	**22**

* - Lab sessions on application of Mathematics in Electrical Engineering using professional software.

- Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week :Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field .

$ - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week : IOT application in Electrical Engineering using microcontroller and GSM module to bridge gap between curriculum and enhance application knowledge.

Abbreviation: TH: Theory, PR: Practical, TUT:Tutorial, ISE: Insem Exam, ESE: End Sem Exam, TW: Term Work, OR: Oral

Engineering Mathematics-III
(207006)

Subject - Engineering Mathematics-III(207006)

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	3	-	-

In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	-	-	100	3

Subject- Engineering Mathematics III(207006)
SE Electrical

After completion of the course , students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Linear differential equations of higher order applicable to control systems.
2. Transforms such as Laplace transform, Fourier transform, Z-Transform and applications to Control systems ans Signal processing.
3. Vector differentiation and integration required in Electro-Magnetics and Wave theory.
4. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image processing.

Course Outcomes

At the end of this course, students will be able to:
CO1: Solve higher order linear differential equation using appropriate techniques to model and analyze electrical circuits.
CO2: Apply Integral transforms such as Laplace transform, Fourier transform and Z-Transform to solve problems related to signal processing and control systems.
CO3: Apply Statistical methods like correlation, regression and Probability theory as applicable to analyze and interpret experimental data related to energy management, power systems, testing and quality control.
CO4: Perform Vector differentiation and integration, analyze the vector fields and apply to wave theory and electro-magnetic fields.
CO5: Analyze Complex functions, conformal mappings, and perform contour integration in the study of electrostatics, signal and image processing.

Text Books:

[T1] Erwin Kreyszig, "Advanced Engineering Mathematics", 9e,(Wiley India).
[T2] Peter V. O'Neil, "2. Advanced Engineering Mathematics", 7e,(Cengage Learning).

Reference Books:

[R1] M. D. Greenberg, "Advanced Engineering Mathematics", 2e, Pearson Education
[R2] Wylie C.R. & Barrett L.C. "Advanced Engineering Mathematics", McGraw-Hill, Inc.
[R3] B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi.
P. N. Wartikar & J. N. Wartikar, "Applied Mathematics (Volumes I and II)", Pune VidyarthiGriha Prakashan, Pune.
[R5] B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill. Thomas L. Harman, James Dabney and Norman Richert,
[R6] "Advanced Engineering Mathematics with MATLAB", 2e, Brooks/Cole, Thomson Learning.

Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

www.wolframalpha.co.in

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Teaching Plan

Engineering Mathematics-III

Sr. No.	Unit	Topics to be covered	Book Referred	Total Lecture Planned
1	1	• Complimentary function. • General Method to find particular integral. • Shot cut Methods to find particular integral. • Method of Variation of parameters to find particular integral. • Method of Variation of parameters to find particular integral. • Legendre linear differential equations • Solution of Symmetric simultaneous Differential equations. • Application to Mass spring system,free & Force damped & undamped systems	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	10
2	2	• Introduction To Laplace Transform • Laplace Transform of standard function • Properties and theorems of Laplace transform • Inverse Laplace Transform • Laplace Transform of special function Periodic, Unit Step, Unit Impulse • Application of Laplace transform	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	9
3	3	• Introduction to Fourier Integral Theorem, Fourier Sine and Cosine Integrals. • Fourier Sine and Cosine Transforms and their Inverses. • Properties and theorems of Fourier Transforms and Finite Fourier Transforms. • Fourier Transforms and Fourier sine and cosine transforms of derivatives. • Introduction to Z-Transform	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	9

		• Properties and Z transform of some standard sequences. • Introduction to Inverse Z-Transform, Finding Inverse Z-Transform • Solution of Difference equations with constant coefficients using Z transforms. • Introduction to Fourier Integral Theorem, Fourier Sine and Cosine Integrals. • Fourier Sine and Cosine Transforms and their Inverses.		
4	**4**	• Introduction to vector Algebra and Vector Differentiation • Application to Mechanics, radial and Transverse components of Velocity and acceleration. • Gradient of a scalar field, directional derivative. • Examples on Divergence and Curl of a vector point function. • Application to Mechanics, radial and Transverse components of Velocity and acceleration. • Vector identities..	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	**9**
5	**5**	Vector integration. Line Integral. Work Done Green's lemma with examples. Gauss Divergence Theorem with examples Gauss Divergence Theorem with examples Stroke's Theorem with examples Stroke's Theorem with examples Application to Problem in electromagnetic field	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	**9**
6	**6**	Functions of a complex variable, Analytic Functions Examples on Analytic Functions Cauchy Riemann conditions.	1.Engineering Mathematics By B.S Grewal 2.Advanced Engineering Mathematics By Erwin	

		Complex Integration. Cauchy's Theorem and Cauchy integral Formula Residue Theorem. Conformal mapping. Bilinear transformations.	Kreyszig 3.Advanced Engineering Mathematics By Peter V.O'Neil 4.Higher Engineering Mathematics By B.V.Ramana	

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DEPARTMENT OF ELECTRICAL ENGINEERING

Academic Activity Planner

Units	Unit Test1 (10marks)	Unit Test2 (20marks)	MCQ (20marks)	Assignment (Each 20marks)
1	√		√	√
2	√		√	√
3				√
4		√		√
5		√		√
6		√		√

Question Bank:

Unit 1: Linear Differential Equation

Q.1 Solve the following:

1] $(D^2-4D+3)y=x^3.e^{2x}$ 2] $(2x+1)^2\frac{d^2y}{dx^2}-2(2x+1)\frac{dy}{dx}-12y=6x$

3] $((D^2-D)y=4e^x+2^{-x}$ 4] $(D^2-2D+2)y=e^x tanx$ (By VOP)

5] $\frac{d^2y}{dx^2}-3\frac{dy}{dx}+2y=x^2+sinx$ 6] $(D^2+1)y=cosecx$ (By VOP)

7] $x^3\frac{d^2y}{dx^2}+3x^2\frac{dy}{dx}+xy=\cos(logx)$ 8] $\frac{xdx}{y^2z}=\frac{dy}{xz}=\frac{dz}{y^2}$

9] $(D^2+3D+2)\,y=e^{e^x}+\cos e^x$ 10] $\frac{dx}{x(2y^4-z^4)}=\frac{dy}{y(z^4-2x^4)}=\frac{dz}{z(x^4-y^4)}$

11] $(D^2-2D+2)y=e^{e^x}\tan x$ 12] $\frac{d^2y}{dx^2}-2\frac{dy}{dx}+2y=x^2+e^{-x}+1$

13] $(D^2-3D+2)y=xe^{3x}+\sin 2x$ 14] $\frac{d^4y}{dx^4}-2\frac{d^2y}{dx^2}-8y=\cosh 2x+2^{-x}$

15] $y''-6y'+9y=\frac{e^{3x}}{x^2}$ (by VOP) 16] $\frac{d^2y}{dx^2}+\frac{dy}{dx}=\frac{1}{1+e^x}$

17] $(D^2+1)y=secx$ (by VOP) 18] $(D^4-1)y=cosx\,coshx$

19] $(x^2D^2-xD+4)y=\cos(logx)+xsin(logx)$

20] $\frac{dx}{y+zx}=\frac{dy}{-x-yz}=\frac{dz}{x^2-y^2}$ 21] $(D^2-4D+3)y=x^3e^{2x}$

22] $[(3x+2)^2D^2+3(3x+2)D-36]y=3x^2+4x+1$ 23] $(D^2-6D+9)y=\frac{e^{3x}}{x^2}$

24] $(D^2+1)y=sinx\,sin2x$ 25] $(D^2+1)y=cosecx$ (by VOP)

26] An electric curcuit consists of an inductance 0.1H,resistance of 20Ω and capacitance of 25 μF. If differential equation is $\left(LD^2q+RDq+\frac{q}{c}\right)=0$.Find charge q, current i at any time t. Given at t=0, q=0.05 coulomb, i=0 .

27] An e.m.f. E sin pt is applied at t = 0 to a circuit containing a condenser C and inductance L in series. The current x satisfies the following equation

$L\frac{dx}{dt}+\frac{1}{C}\int xdt=E\sin pt$, where x = $-\frac{dq}{dt}$.

If $p^2=\frac{1}{LC}$ and initially the current x charge q are zero, show that the current in the circuit at time t is given by

$\frac{E}{2L}t\sin pt.$

28] An electric circuit consists of an inductance 0.1H, capacitance of 4μF. A generator having e.m.f. given by 180 cos 40t, t>=0 are connected in series.Find charge q, current i at any time t. Given at t=0, q=0 coulomb, i=0 .

29] Solve: (D-1)x+Dy=t , $3x+(D+4)y=t^2$

Unit 2 Laplace Transform

1. Find the Laplace Transform of the following functions .

a) $\frac{e^{-at}-e^{-bt}}{t}$ b) $\int_0^t t.e^{-t}.sin2tdt$ c) $tsin^3t$ d) $\int_0^t \frac{\cos 2t-e^t}{t}dt$

e) $\frac{\cos\sqrt{t}}{\sqrt{t}}$ f) $\frac{e^{-3t}.sin2t}{t}$ g) $e^{-3t}\int_0^t t.sin2tdt$ h) $g(t)=\begin{cases}\cos\left(t-\frac{2\pi}{3}\right), t>\frac{2\pi}{3}\\ 0, t<\frac{2\pi}{3}\end{cases}$

j) $\int_0^t \frac{sint}{t}dt$ k) $\int_0^t te^{-4t}sin3t\,dt$ l) $\frac{d}{dt}\left(\frac{sint}{t}\right)$ m) $f(t)=t.e^{3t}sin2t$

2. Find the values of following integrals using Laplace Transform

a) $\int_0^\infty t^2\,e^{-3t}\sinh 2tdt$ b) $\int_0^\infty \frac{1-\cos 2t}{t^2}dt$ c)) $\int_0^\infty \frac{e^{at}-e^{bt}}{t}dt$

3. *Find inverse Laplace Transform of the following functions.*

a) $\log\left(1+\frac{a^2}{s^2}\right)$ b) $\frac{s^2+2s-3}{(s-3)(s+2)^2}$ c) $\frac{5s+3}{(s-1)(s^2+2s+5)}$ d) $\frac{s^2+2}{s(s^2+4)}$ e) $\frac{2s^2-6s+5}{s^3-6s^2+11s-6}$

f) $\cot^{-1}\left(\frac{s+1}{2}\right)$ g) $\frac{1}{s}log\left(\frac{s^2+a^2}{s^2+b^2}\right)$ h) $\cot^{-1}\left(\frac{s-2}{3}\right)$

i) $\log\left(\frac{s^2+1}{s(s+1)}\right)$ j) $\frac{1}{s\sqrt{s+4}}$ k) $\frac{2s+5}{s^2+4s+13}$

4. *Find inverse Laplace Transform by convolution theorem*

a) $\frac{1}{(s+3)(s-2)^4}$ b) $\frac{1}{(s+1)(s^2+1)}$ c) $\frac{1}{s^3(s^2+1)}$

5. Solve by Laplace transform

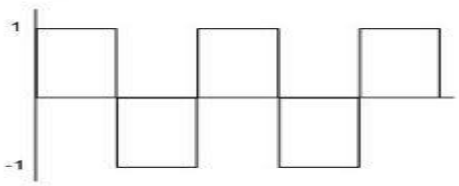
a) $\frac{dx}{dt}+4x(t)+5\int_0^t x(t)dt=e^{-t}, where x(0)=0$

b) $\frac{d^2x}{dt^2}+2\frac{dx}{dt}+x=6te^{-t}, where x(0)=0, x'(0)=5$

c) $\frac{d^2y}{dt^2}+2\frac{dy}{dt}+5y=e^{-t}sint, where y(0)=0, y'(0)=1$

d) $\frac{d^2y}{dx^2}+3\frac{dy}{dx}+2y=12e^{-2t}, where y(0)=2, y'(0)=6$

6. Find the Laplace Transform of "square wave" (rectangular wave) as shown below



7.Find the Laplace Transform of each of the following :

a) sint U(t-4)

b) $f(t) = \begin{cases} t^2, 0 < t < 1 \\ 4t, t > 1 \end{cases}$

c) $te^{-2t}\delta(t-2)$

d) Prove that $\int_{-\infty}^{\infty} f(t)\delta'(t-a)dt = -f'(a)$ where $\delta'(t-a)$ is derivative.

Unit 3:Fourier Transform& Z-Transform

1. Find the fourier integral representation of the function

$$f(x)=\begin{cases}1, |x|<1\\ 0, |x|>1\end{cases}$$

and hence (a) evaluate $\int_0^\infty \frac{\sin\lambda\cos\lambda x}{\lambda}d\lambda$ (b) Deduce that $\int_0^\infty \frac{\sin\lambda}{\lambda}d\lambda$

2. By considering Fourier sine and cosine integrals of e^{-mx} (m>0),Prove that

$$\int_0^\infty \frac{\lambda\sin\lambda x}{\lambda^2+m^2}d\lambda=\frac{\pi}{2}e^{-mx}, \text{m>0 ,x>0}$$

3. Using Fourier integral representation of the function

(a) $\int_0^\infty \frac{\lambda^3\sin\lambda x}{\lambda^4+4}d\lambda=\frac{\pi}{2}e^{-x}\cos x,$ where x>0

(b) $\int_0^\infty \frac{\cos\frac{\pi\lambda}{2}\cos\lambda x}{1-\lambda^2}d\lambda=\begin{cases}\frac{\pi}{2}\cos x, |x|\le\frac{\pi}{2}\\ 0, |x|>\frac{\pi}{2}\end{cases}$

4. Find the Fourier transform of :

$$f(x)=\begin{cases}1-x^2, |x|\le 1\\ 0, |x|>1\end{cases}$$

and hence evaluate $\int_0^\infty\left(\frac{x\cos x-\sin x}{x^3}\right)\cos\frac{x}{2}dx$

5. Find the Fourier sine transform of : $f(x)=\frac{e^{-ax}}{x}$

6. Show that Fourier cosine transform of : $f(x)=e^{-|x|}$ is $\frac{2}{1+\lambda^2}$

7.Find the Fourier sine transform of : $f(x)=\frac{e^{-ax}}{x}$

8. Q.2 Using Fourier integral representation of the function Prove:

$$\int_0^{\infty} \frac{\cos\lambda x + \lambda \sin \lambda x}{1+\lambda^2} d\lambda = \begin{cases} 0, |x| > \frac{\pi}{2} \\ \frac{\pi}{2}, x = 0 \\ \pi e^{-x}, x > 0 \end{cases}$$

9. Solve the integral equation $\int_0^{\infty} f(x) \sin \lambda x d\lambda = \begin{cases} 1; 0 \le \lambda \le 1 \\ 2; 1 \le \lambda < 2 \\ 3; \lambda \ge 2 \end{cases}$ is

Problems on Z-transform

10. Find the Z-transform of:

i) $f(k) = 2^k \cos(3k+2)$ ii) $f(k) = \left(\frac{1}{5}\right)^{|k|}$, *for* all k

ii) $f(k) = \sin\left(\frac{k\pi}{4} + \alpha\right), k \ge 0$

iv) $f(k) = (k+1)a^k, (k \ge 0)$

V) $f(k) = \frac{\sin ak}{k}, k > 0$

vi) $f(k) = \begin{cases} 2^k, k < 0 \\ \left(\frac{1}{2}\right)^k, k = 0,2,4,6,.... \\ \left(\frac{1}{3}\right)^k, k = 1,3,5,..... \end{cases}$

Problems on Inverse Z-transform

11. Find :

i) $z^{-1}\left(\frac{1}{(z-3)(z-2)}\right), 2 < |z| < 3$

ii) $z^{-1}\left(\frac{3z^2+2z}{z^2-3z+2}\right), 1 < |z| < 2$

iii) $z^{-1}\left[\frac{z^3}{(z-1)\left(z-\frac{1}{2}\right)^2}\right], |z|>1$

Problems on Application of Z-transform

1. Obtain f(k) ,given that
   12 f(k+2) – 7 f(k+1) + f(k) =0 ; k ≥ 0 ,f(0)=0 ,f(1)=3.
2. Solve the difference equation f(k+2)+3f(k+1)+2f(k)=0, f(0)=0 ,f(1)=1

Unit-4: Statistics and Probability

1] Find the constants a and b such that the surfaces $ax^2 - 2byz = (a+4)x$ and $4x^2y + z^3 = 4$, are orthogonal at the point (1,-1,2).

2] A fluid motion is given by $\vec{v} = (y\sin z - \sin x)\vec{i} + (x\sin z + 2yz)\vec{j} + (xy\cos z + y^2)\vec{k}$. Is the motion irrotational. If so, find the velocity potential.

3] Prove that :

i) $\nabla(\bar{r}.\bar{u}) = \bar{r}\times(\nabla\times\bar{u}) + (\bar{r}.\nabla)\bar{u} + \bar{u}$

ii) $\nabla\times(\bar{r}\times\bar{u}) = \bar{r}(\nabla.\bar{u}) - (\bar{r}.\nabla)\bar{u} - 2\bar{u}.$

4] Find the directional derivative of $\phi(x,y,z) = x^2yz + 4xz^2$ at (1,-2,1) in the direction of $2i - j - 2k$. find the greatest rate of increase of ϕ.

5] Find the angle between the surfaces $xy^2 + z^3 + 3 = 0$ and $x\log z - y^2 + 4 = 0$ at (-1,2,1)

6] For constant vector $\vec{a}$, show that

7] i) $\nabla(\vec{a}.\vec{r}) = \vec{a}$

8] ii) $\nabla\times(\vec{a}\times\vec{r} = 2\vec{a})$

iii) $\nabla\left(\frac{\vec{a}.\vec{r}}{r^n}\right) = \frac{\vec{a}}{r^n} - \frac{n(\vec{a}.\vec{r})}{r^{n+2}}\vec{r}$

9] If particle moves always on the surface of sphere prove that,

$i)\ \bar{r}\cdot\bar{a} + \bar{v}\cdot\bar{v} = 0 \quad ii)\ \bar{r}\cdot\bar{a} \le 0.$

10] Find the directional derivative $\phi = x^2y + y^3z$ at $(2,-1,1)$ along the direction which makes a equal angle with co-ordinate axes.

11] Find the values of $'\alpha'$ and $'\beta'$ so that the surfaces  are orthogonal to each other at $(1,-2,1)$.

12] If the directional derivative of $\phi = axy^2 + byz + cz^2x^3$ at $(1,2,-1)$ has maximum magnitude '64' in a direction parallel to Z-axis, find the values of a, b, and c.

13] Find the directional derivative of the function $\phi = e^{2xyz}$ at (1,1,1) in the direction of tangent to the curve  .

14] Find the directional derivative of the function $\phi = x^2 - y^2 + 2z^2$ at the point $(2,-1,3)$ alo the direction normal to the surface $x^2 + y^2 + z^2 = 9$ at (2,-1,3).

15] For a function $\phi(x,y) = \frac{x}{x^2+y^2}$, find the magnitude of directional derivative along a line mak an angle 30° with the positive X-axis at (0, 1).

16] If  is conservative find a, b, c and wo done in moving a particle in the field from the point $(1,1,1)$ to the point $(2,1,3)$.

17] Show that the field given by  is conservative and hence find the scalar potential $'\phi'$ such that $\bar{F} = \nabla\phi$.

18] If  show that $\bar{F}_1\times\bar{F}_2$ is solenoidal.

19] Find the directional derivative of $\phi = x^2 - y^2 - 2z^2$ at the point $P(2,-1,3)$ in the direction PQ, where $Q(5,6,4)$.

20] If the directional derivative of  at (1, 1, 1) has maximum

magnitude 12 in the direction parallel to the line $\frac{x-1}{1}=\frac{y-2}{2}=\frac{z-1}{3}$,find the values of a, b,

The directional derivative of $\phi(x,y)$ at the point A(3,2) towards the point B(2,3) is $3\sqrt{2}$ ar towards the point C(1,0)is $\sqrt{8}$ .Find the directional derivative at A towards the D(2,4).

Prove that the following vector identity:

22]

1) 

2) 

3) 

4) $\nabla^2\left[\frac{\bar{a}\cdot\bar{b}}{r}\right]=0$

5) 

6) If $\rho\bar{E}=\nabla\phi$, prove that $\bar{E}\cdot curl\,\bar{E}=0$

7) 

8) 

9) 

10) 

23] Show that $\vec{F}=\frac{xi+yj}{x^2+y^2}$ is solenoidal as well as irrotational.

Evaluate $\int \vec{F}.\vec{dr}$

24] Find the angle between tangents to the curve $x=t^2, y=2t, z=-t^3$ at Points t = 1 & t = -1

25] Find the constants a & b, so that the surface $ax^2-byz=(a+2)x$ will be orthogonal to the Surface $4x^2y+z^3=4$ at the point $(1,-1,2)$.

Unit 5:Vector Calculus

1.Find the work done in moving a particle from $(0,1,-1)\,to\,(\frac{\pi}{2},-1,2)$ in a force Field $\vec{F}=(y^2\cos x+z^3)\vec{i}+(2y\sin x-4)\vec{j}+(3xz^2+2)\vec{k}$

2.Evaluate $\int_c \vec{F}.d\vec{r}$, for $\vec{F}=(2y+3)\vec{i}+(xz)\vec{j}+(yz-x)\vec{k}$. Along the path $x^2=2t^2, y=t, z=t^3.$ from $t=0$ to $t=1.$

3.A vector field is given by $\vec{F}=\sin y\,\vec{i}+x(1+\cos y)\vec{j}$, evaluate the line integral $\int_c \vec{F}.d\vec{r}$, where 'c' is the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1, z=0.$

4.Verify Green's lemma for the field $\vec{F}=(x^2+xy)\vec{i}+(x^2+y^2)\vec{j}$ for the boundary of the square formed by the lines $x=\pm1, y=\pm1.$

5.verify stokes theorem for $\vec{F}=yz\,\vec{i}+zx\,\vec{j}+xy\,\vec{k}$ *and* C is the curve intersection of $x^2+y^2=1 and\ y=z^2.$

6.Apply stokes theorem to evaluate $\int_c 4y\,dx+2z\,dy+6y\,dz$, where 'C' is the curve of intersection of $x^2+y^2+z^2=6z\ and\ z=x+3.$

7.Evaluate $\iint_s (\nabla\times\vec{F})\,ds$ *where* $\vec{F}=(x-y)\vec{i}+(x^2+yz)\vec{j}-3xy^2\vec{k}$ and S is the surface of the cone $z=4-\sqrt{x^2+y^2}$ above the XOY plane.

8.Evaluate $\iint_s xz^2dy\,dz+(x^2y-z^2)dz\,dx+(2xy+y^2z)dx\,dy\ where$ S is the surface enclosing a region bou hemisphere $x^2+y^2+z^2=4\ above\ XOY\ plane.$

9.Verify Guass Divergence theorem $\vec{F}=(x^2-yz)\vec{i}+(y^2-zx)\vec{j}+(z^2-xy)\vec{k}$ over the cube whose sides is 'a'.

10.Two of Maxwell's electromagnetic equation are $\nabla\cdot\vec{B}=0, \nabla\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}, given\ \vec{B}=curl\ \vec{A}$ then deduce that $\vec{E}+\frac{\partial\vec{A}}{\partial t}=-grad\,V\ where V\ scalar\ point\ function.$

11.Use Maxwell's equations $i)\ \nabla\cdot\vec{E}=0,\ ii)\ \nabla\cdot\vec{H}=0,\ iii)\ \nabla\times\vec{E}=-\frac{\mu}{C}\frac{\partial\vec{H}}{\partial t},\ iv)\nabla\times\vec{H}=\frac{K}{C}\frac{\partial\vec{E}}{\partial t}$

To show that both $\vec{E}\ and\ \vec{H}$ satisfy wave equation $\nabla^2\vec{A}=\frac{\mu K}{C^2}\frac{\partial^2\vec{A}}{\partial t^2}.$

Unit 6: Complex Variables

1. Show that analytic function with constant amplitude is constant.
2. Find bilinear transformation which maps 0,-1,i of z into $2,\infty,\frac{1}{2}(5+i)$ of w-plane.
3. Evaluate $\oint_c \frac{4z^4+2}{z^2-1}dz$ where ,c is circle $|z-1|=\frac{1}{2}$.

   Find bilinear transformation for z= 1,i,2i w=-2i,0,1
4. If $u=\frac{1}{2}\log(x^2+y^2)$ find $v, f(z)$ is analytic and find $f(z)$ in terms of .
5. By Residue theorem evaluate $\int_c \frac{\sin \pi z^2+2z}{(z-1)^2(z-2)}dz$, where c is circle$|z|=4$.
6. Evaluate $\int_C \frac{z^2+1}{z-3}dz$ where

i)C is the circle $|z-2|=2$

ii)C is the circle $|z|=2$

7. Find the map of the straight line y=2x under the transformation

$$w=\frac{2z-1}{2z+1}$$

8. Evaluate $\int_C \frac{z^2+2z}{(z+1)^3(z^2-9)}dz$ where C is the circle $|z|=4$,using residue theTheorem
9. If $v=4xy(x^2-y^2)$ find it's harmonic conjugate u and find analytic function $f(z)=u+iv$ in terms

   of z.
10. Find the map of the straight line y=2x under the transformation

$$w=\frac{2z-1}{2z+1}$$

11. Find the bilinear transformation which maps the points –i,0,2+i of the z-plane on to the 0,-2i,4 of the w-plane.
12. Find the bilinear transformation which maps the points 1,0,i of the z-plane 0,-2, $-\frac{1}{2}$(1+i) of the w-plane.
13. Evaluate $\int_C \frac{z^2}{(z^2+1)^2(z^2-9)}dz$ where C is the semicircular contour $|z|=2$, I(z)≥ 0 using

    residueTheorem
14. Evaluate $\int_c \frac{dz}{z-z_0}$

i)C is the closed contour containing the point z_0

ii) Point z_0 is outside the contour C.

15. Find the residue of f(z)= $\frac{z}{(z-1)^2(z-2)(z-3)}$ at its poles and hence evaluate :

$\int_C f(z)dz$,

where C is the circle |z|=4.

16.If f (z) is analytic, show that : $(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2})|f(z)|^4 = 16|f(z)|^2 \times |f'(z)|^2$

Point z_0 is outside the contour C.

17.Find the map of the straight line y=x under the transformation : w= $\frac{z-1}{z+1}$.

18.Evaluate: $\int_{2+4i}^{5-5i}(x+iy+1)dz$ along the path x= t^2 +1, y=3t +1.

19.Show that analytic function with constant modulus is constant.

20.Find the bilinear transformation which maps the points 1, i, 2i of z-plane onto points -2i, 0,1 of W-plane.

POWER GENERATION TECHNOLOGIES

Name of the Subject: Power Generation Technologies

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	03	-	-

Online/ In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	-	-	100	03

Syllabus:

Unit 01 : Thermal Power Plant (9 Hrs)

Basic thermodynamic cycles: Thermodynamic cycle of steam flow; Rankine cycle; Actual Rankine cycle; Reheat cycle; Carnot cycle, heat rate.

Thermal Power Plants: Site selection, Main parts and its working. Types of boilers, Feed water and its treatment, Various boiler controls, assessment of heat recovery systems Steam turbines types, selection and control of turbines.

Fuel Handling: delivery of load, unloading, preparation, transfer, outdoor (dead) storage, indoor (live) storage, In-plant Handling, Coal weighing.

Ash disposal and dust collection : Draught systems, electrostatic precipitator. RecentDevelopment in thermal power plants.

Unit 02 : (9 Hrs)

A. **Nuclear Power Plant:** Introduction, atomic physics, nuclear reaction, materials, siteselection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal, plant layout. Recent Development in nuclear power plants.

B. **Diesel Power Plants:** Main components and its working, Diesel plant efficiency andheat balance, choice and characteristic of diesel power plant. Selection of components and sizing.

C. **Gas Power Plant:** Introduction to gas cycles. Simple gas turbine power plant, methodsto improve thermal efficiency, open loop and closed loop cycle power plants, gas fuels, gas turbine materials, plant layout. Combined cycle power plants and concept of heat to power ratio. Recent Development in Gas power plants.

Unit 03: Hydro Power Plant (8 Hrs)

Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power

plant, Hydraulic turbines, turbine size, pelton wheel turbine, Francis and Kaplan turbines, selection of turbines, Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank, simple numerical on hydrographs and number of turbine required. Control of hydro turbines. Small, mini and micro hydro power plant, Recent Development in hydro power plants.

Unit 04 Wind Energy Systems (8 Hrs)

Historical Development of Wind Power, Types of wind turbine electrical generators, Power in the Wind, Impact of Tower Height, Maximum Rotor efficiency, Speed control for Maximum Power, Average Power in the wind, Wind turbine power converters (block diagrams), Wind Turbine Economics, Simple Estimates of Wind Turbine Energy, Environmental Impacts of Wind Turbines. Change in wind pattern and its effect on power generation. Control of wind turbine generator.

Unit 05 : Solar Energy (8 Hrs)

Principles of solar radiations, solar constant, cloudy index and concentration ratio, measurement of solar radiation. Solar energy collectors (solar thermal applications), principle of energy conversion, collection systems and their features, types of collectors with comparison. Solar thermal power plants. Over view of recent development of PV technologies. A Generic Photovoltaic Cell, The Simplest Equivalent Circuit for a Photovoltaic Cell From Cells to Modules to Arrays, The PV I–V Curve under Standard Test Conditions (STC), Impacts of Temperature and Insolation on I–V Curves, Shading Impacts on I–V curves, System: Introduction to the Major Photovoltaic System Types.

Unit 06 : Other Sources and Grid Connection (6 Hrs)

Biomass energy, conversion to electricity, municipal solid waste to energy conversion, geothermal energy and ocean energy and Fuel cell Energy storage requirements and selection criteria, stand alone, hybrid stand alone and grid connected renewable systems and their requirements.

Industrial Visit: One industrial visit to conventional /non-conventional power plant is necessary. A separate report file should be maintained in the department.

Text Books:

[T1] P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
[T2] Dr. P. C. Sharma, "Power Plant Engineering", S.K. Kataria Publications.
[T3] R. K. Rajput, "A text book on Power System Engineering", Laxmi Publications (P) Ltd.

[T4] Chakrabarti, Soni, Gupta, Bhatnagar, "A text book on Power System Engineering", DhanpatRai publication.
[T5] R.K. Rajput, "Non-Conventional Energy Sources and Utilization", S. Chand Publications.
[T6] M.M. Wakil, "Power Plant Engineering", McGraw Hill, Indian Edition.
[T7] G. D. Rai, "Renewable Energy Sources", Khanna Publications.

Reference Books:

[R1] Arora and Domkundwar, "A Course in Power Plant Engineering", DhapatRai Publication.
[R2] Dr. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.
[R3] Mukund Patel, "Wind and Solar Power Plants", CRC Press.
[R4] Gilbert Masters John, "Renewable Energy", Wiley and sons' publications.

Unit	Text Books	Reference Books
1	T1,T2,T3	R1
2	T1,T2,T3	R1
3	T1,T2,T3	R1
4	T6,T7	R3,R4
5	T5,T6	R2,R3,R4
6	T5,T7	R4

Course Objectives

From the study of this course students will learn:

- To Introduce conventional energy conversion system with steam, hydro based and nuclear based power plant.
- To initiate non-conventional energy conversion system with solar, wind, fuel cell, tidal ocean, geothermal, biomass etc.
- To Commence interconnection of energy source to gird, stand alone and hybrid system.

Course Outcomes:

After successfully completing the course students will be able to:

- Identify operations of thermal power plant with all accessories and cycles.
- Be aware of the principle of operation, components, layout, location, environmental and social issues of nuclear, diesel and gas power plant.
- Identify and demonstrate the components of hydro power plant and calculation of turbine required based on catchment area.
- Find the importance of wind based energy generation along with its design, analysis and comparison.
- Apply solar energy in thermal and electrical power generation considering energy crisis, environmental and social benefits.
- Understand the operation of electrical energy generation using biomass, tidal, geothermal, hydel plants, fuel cell and interconnection with grid.

- **Academic Activity Planner**

Units	MCQ	Unit Test	Open Book Test
1	30	15	-
2	30	15	-
3	30	15	30M
4	30	15	
5	30	15	
6	30	15	

Teaching Plan

Teaching plan as per University Syllabus

Sr.No.	Unit	Broad Topics to be Covered	Total Lecture Planned
1	I	Thermal Power Plant	06
2	II	Nuclear Power Plant Diesel Power Plants Gas Power Plant	06
3	III	Hydro Power Plant	06
4	IV	Wind Energy Systems	06
5	V	Solar Energy	06
6	VI	Other Sources and Grid Connection	06

PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

Unit wise Lecture Plan

Unit No.-I: Thermal Power Plant

Pre-requisites:- Calorific value of fuel, basics of steam power plant

Objectives:-

- To understand the working and site selection of steam power plant.
- To study the different thermodynamic cycles.
- To understand the necessity of fuel handling and dust collection.

Outcomes:

- **Understand** the how steam power plant is working and how to select the site of power plant.
- **Understands the** necessity of fuel handling.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Subject introduction, Course objectives and Outcomes, Pre-requisites for this subject. Discussion on pre-requisite for unit 1.**	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
2	**Basic thermodynamic cycles:** Thermodynamic cycle of steam flow; Rankine cycle, Actual Rankine cycle; Reheat cycle; Carnot cycle, heat rate.	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
3	**Thermal Power Plants:** Site selection, Main parts and its working. Types of boilers , , assessment of heat recovery systems	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
4	**Coal handling System, Ash handling system**	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
5	**Ash disposal and dust collation**: Draught systems, electrostatic precipitator.	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
6	Numericals on heat rate, FBC Boiler	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory
Unit: I

1. Explain working of super heater used in thermal power plant with t the help of neat circuit diagram.
2. Write short note on "Feed Water Treatment" for thermal power plant.
3. What are the advantages of Rankine cycle over Carnot cycle.
4. What are the factors to be considerd for the selection of a site for thermal power plant.
5. Write short note on "jet type condenser" for thermal power plant.
6. Explain working of economizer use in thermal power plant with the help of diagram.
7. Write the types of boilers in the thermal power plant and explain any one of them with the help of diagram.
8. Explain rankine cycle and actual rankine cycle with the help of diagram and state the difference between them.
9. What is a function of draught system in thermal power plant and explain it with the help of diagram.
10. With the help of diagram explain parts of thermal power plant.
11. What are the types of steam turbine.? Briefly discuss their use and characteristic.
12. Explain general layout of stem power plant
13. Write a short note on coal handling and Ash handling power plant.

Unit No.-II Nuclear Power Plant, Diesel Power Plants, Gas Power Plant

Pre-requisites:-
Basic concepts of nuclear reaction, general idea of diesel and gas power plant.

Objectives:-
To learn different power generation techniques, it's site selection, efficiency.

Outcomes:-After successfully completing this unit students will be able:
To understand the different technology of power generation, which one is efficient.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**A) Nuclear power plant:** Introduction, atomic physics, nuclear reaction, materials, nuclear reactors and, working of each part,	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
2	Classification of nuclear reactor	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
3	**B) Diesel Power Plants:** Main components and its working	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
4	Selection of components and sizing.	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
5	**C)Gas power plant:** Introduction to gas cycles. Simple gas turbine power plant methods to improve thermal efficiency, open loop and closed loop cycle power plants	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
6	gas fuels, gas turbine materials, plant layout Combined cycle power plants and concept of heat to power ratio.	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory
Unit 2

1. What is boiling water reactor ? Explain it with a neat sketch .How does it differ from pressurized water reactor(PWR)?

2. Explain with a neat sketch working of CANDU nuclear reactor.

3. What factors are considered while selecting a site for diesel power plant? Also state the application of diesel power plant.

4. Enlist the main components of diesel power plant .

5. Write a short note on nuclear waste disposal.

6. Explain open loop and closed loop cycle gas power plant.

7. What is thre role of reheating and intercooling for performance improvement in gas turbine power plant.

Unit No.-III: Hydro Power Plant

Pre-requisites :-
Basics of energy generation from hydro power plant.

Objectives :-
To learn the energy generation from hydro power plant.

Outcomes:-After successfully completing this unit students will be able to:
Understand the how the energy is generated from hydropower plant.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Hydro Power Plant** Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power plant	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
2	Hydraulic turbines, turbine size , pelton wheel turbine, Francis and Kaplan turbines,	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
3	Selection of turbines ,Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
4	Simple Numerical on hydrographs and number of turbine required	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
5	simple numerical on hydrographs and number of turbine required	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)
6	Control of hydro turbines	T1,T2,T3 R1	Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory

1) Explain the working of Francis turbine with neat diagram

2) Write a short note on spillways and penstock in turbine.

3) Give the functions of following components

   i).Spillways (ii) Pondage (iii) Dam (iv) Penstock

4) Differentiate horizontal axis and vertical axis wind turbine.

5) What are the factors used to select the site of hydro power plant?

6) Short note on control of hydroturbines

7) Short note on dam

8) Difference between francis turbine and Kaplan turbine.

Unit No.-IV: Wind Energy Systems

Pre-requisites:- Concept of motivation, leadership.

Objectives:-

- To learn the concept, need of motivation.
- To study group dynamics and different theories of it.
- Qualities of leader.

Outcomes:-After successfully completing this unit students will be able to:

- Analyze the need of motivation
- How to work in group and team
- Become a good leader.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Wind Energy Systems** Historical Development of Wind Power, Types of wind turbine electrical generators	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)
2	Power in the Wind, Impact of Tower Height, Maximum Rotor efficiency,	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)
3	Speed control for Maximum Power, Average Power in the wind, Wind turbine power converters (block diagrams),	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)
4	Wind Turbine Economics , Simple Estimates of Wind Turbine Energy, Environmental Impacts of Wind Turbines	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)
5	Change in wind pattern and its effect on power generation	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)
6	Control of wind turbine generator.	T6,T7 R3,R4	Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory

1)Explain grid connected wind energy conversion system with the help of neat diagram.

2)Why wind energy is preferred? Write advantages and disadvantages of wind energy.

3) Describe how the height of wind tower influences the wind

power plant working

4) Explain how wind power plant affects environment.

5) Differentiate horizontal axis and vertical axis wind turbine.

6) Explain grid connected wind energy conversion system with the help of neat diagram.

7) Why wind energy is preferred? What are its advantages and disadvantages?

8) Explain grid connected wind energy conversion system with neat diagram.

9) What is impact of power height on wind energy?

10) Explain block diagram of wind turbine power converter.

Unit No.-V: Solar Energy

Pre-requisites:-basics of PV model and its uses.

Objectives:-

- To understand the basic concepts of photo voltaic system.
- Generation of electricity from solar energy and factors affecting on it.

Outcomes:-After successfully completing this unit students will be able to:

- Understand the electricity generation from solar energy and its applications in day to day life.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Solar Energy** Principles of solar radiations, solar constant, cloudy index and concentration ratio, measurement of solar radiation	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)
2	Solar energy collectors (solar thermal applications), principle of energy conversion, collection systems and their features types of collectors with comparison. Solar thermal power plants.	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)
3	Over view of recent development of PV technologies. A Generic Photovoltaic Cell, The Simplest Equivalent Circuit for a Photovoltaic Cell From Cells to Modules to Arrays	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)
4	The PV I–V Curve under Standard Test Conditions (STC),	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)
5	Impacts of Temperature and Insolation on I– V Curves, Shading Impacts on I–V curves	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)
6	system: Introduction to the Major Photovoltaic System Types.	T5,T6 R2,R3,R4	Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory

1) Explain any three application of solar energy conversion.

2) Explain solar cell, module, panel and array with diagram

3) Explain performance curve of PV cell with the help of I-V curves

4) What are solar energy collectors? Write its type and compare them.

5) describe types of major PV system.

6) What are recent developments on PV technology.

7) Explain with sketch MSW to energy conversion plant indicating the function of each part.

8) Explain impact of following on PV system I-V curve:

a. Temperature

b. Shadding

c.insolation

Unit No.-VI: Other Sources and Grid Connection

Pre-requisites:- Basic concepts of other sources of energy,

Objectives: -To learn the different sources of energy generation.

Outcomes:-After successfully completing this unit, students will be able to:
Know the different sources of energy generation.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Biomass energy, conversion to electricity, municipal solid waste to energy conversion	T5,T7 R4	Chalk & Talk/ Online meet (Google Meet)
2	geothermal energy and ocean energy	T5,T7 R4	Chalk & Talk/ Online meet (Google Meet)
3	Small, mini and micro hydel plants	T5,T7 R4	Chalk & Talk/ Online meet (Google Meet)
4	Fuel cell Energy storage requirements and selection criteria, stand alone	T5,T7 R4	Chalk & Talk/ Online meet (Google Meet)
5	hybrid stand alone and grid connected renewable systems and their requirements.	T5,T7 R4	Chalk & Talk/ Online meet (Google Meet)
6	Rubrics		Chalk & Talk/ Online meet (Google Meet)

Question Bank: Theory

1) What is biomass energy? Explain its conversion into electrical energy.
2) note on: a) geothermal energy b) ocean energy
3) explain in detail hybrid standalone system.
4) note on: fuel cell energy requirement and its selection criteria.

MATERIAL SCIENCE

Name of the Subject –Material Science (CODE :203142)

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	03	-	04

Online/ In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	25	25	150	Th-03, Pr-02

Syllabus:

Unit 01: Dielectric Properties of Insulating Materials: (6 Hrs)

Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability], Introduction to Polar and Non- Polar dielectric materials. Mechanisms of Polarizations- Electronic, Ionic and Orientation Polarization (descriptive treatment only), Clausius Mossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta.

Unit 02: A) Dielectric Breakdown: (2 Hrs) Introduction, Concept of Primary and Secondary Ionization of Gases (descriptive treatment only), Breakdown Voltage, Breakdown Strength, Factors affecting Breakdown Strengths of Solid, Liquid and Gaseous dielectric materials.
Unit 02: B) Testing of Materials: (4Hrs)Explanation of following with objectives, equipment required, circuit diagrams and observations to be taken.
1. Measurement of dielectric loss tangent (tan δ) by Schering Bridge-IS 13585-1994.
2. Measurement of dielectric strength of solid insulating material-IS 2584.
3. Measurement of dielectric strength of liquid insulating material -IS 6798.
4. Measurement of dielectric strength of gaseous insulating material as per IS.

Unit 03 : Insulating Materials, Properties & Applications: (6 Hrs)

Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials- Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF_6.
Insulating Materials for Power and Distribution Transformers, Rotating Machines, Capacitors, Cables, Line Insulators and Switchgears.

Unit 04 : Magnetic Materials: (6 Hrs)

Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility, Magnetization], Classification of Magnetic Materials, Diamagnetism, Paramagnetism, Ferromagnetism, Ferri-magnetism, Ferro-magnetic behavior below Critical Temperature, Spontaneous Magnetization, Anti-ferromagnetism, Ferrites, Applications of Ferro magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core, Core of Rotating Machines, Soft Magnetic Materials, Hard Magnetic Materials.

Unit 05 : Conducting Materials: (6 Hrs)

General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High and Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Kanthal, Silver and Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Electrical Carbon Materials. Materials used for Lamp Filaments, Solders, Metals and Alloys for different types of Thermal Bimetal and Thermocouples.

Unit 06 : Nanotechnology: (6 Hrs)

Introduction, Concepts of Energy bands and various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes and applications. Special Topics in Nano Technology such as Single Electron Transistor, Molecular Machines, BN Nanotubes, Nano wires. Nano materials used in Batteries, Photovoltaic Cells and in Supercapacitors.

Industrial Visit:

Minimum one visit should be arranged to an industry related to manufacturing of batteries, capacitors, cables, transformers, motors (Any one industry).

Text Books:

[T1] "A Course in Electrical Engineering Materials", by S.P. Seth, Dhanpat Rai and Sons publication.
[T2] A Textbook of "Electrical Engineering Materials" by R.K.Rajput, Laxmi Publications (P) Ltd.
[T3] "Electrical Engineering Materials", by T.T.T.I, Madras.
[T4] "Electrical Engineering Materials", by K. B. Raina and S. K. Bhattacharya, S. K. Kataria Sons.
[T5] "Material Science for Electrical Engineering", by P.K. Palanisamy, Scitech Pub. Pvt. Ltd., Chennai (India).
[T6] "Introduction to Nanotechnology" by Charles P. Poole, Jr. Frank & J. Ownes (Wiley Student Edition)

Reference Books:

[R1] "Electrical Power Capacitors-Design & Manufacture", by D. M. Tagare, Tata McGraw Hill Publication.
[R2] "Electrical Engineering Materials", by S. P. Chalotra and B. K. Bhattacharya, Khanna Publishers, Nath Market.
[R3] "Electrical Engineering Materials", by C. S. Indulkar and S. Thiruvengadam, S. Chand and Company Ltd.
[R4] "High Voltage Engineering" by Kamraju and Naidu, Tata McGraw Hill Publication.
[R5] "Introduction to Material Science for Engineering", Sixth Edition by James F. Shackelford & M. K. Muralidhara, Pearson Education.
[R6] "Insulation Technology Course Material" of IEEMA Ratner, Pearson Education.
[R7] "Materials Science for Engineering Students", by Traugott Fischer, Elsevier Publications.
[R8]"Energy Conversion Systems", by Rakosh Das Begamudre, New Age International Publishers.
[R9] "Advanced Nanomaterials and Their Applications in Renewable Energy", by Jingbo Louise Liu, Sajid Bashir, ELSEVIER Publications.

Unit No.	Text Book	Reference Book
1	T1, T2	R1, R3, R8
2	T1, T2, T3	R1, R2, R4
3	T1, T2, T3, T4	R1, R3, R4, R6
4	T1, T2, T3, T4	R3, R5
5	T1, T2, T4	R7, R8
6	T6	R9

IS/IEEE Standards:
1. Measurement of Dielectric Loss Tangent (tan _) by Schering Bridge-IS 13585-1994.
2. Measurement of Dielectric Strength of Solid Insulating Material-IS 2584.
3. Measurement of Dielectric Strength of Liquid Insulating Material – IS 6798.

Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

1. http://www.sciencedirect.com
2. http://nptel.ac.in/

Prerequisite:

Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating and resistive along with their basic characteristics.

Course Objectives: The course aims to :

1. Explain classification,properties and characteristics of electrical engineering materials.
2. Describe applications and measuring methods for parameters of dielectric, insulating, magnetic, conducting and resistive materials.
3. Illustrate solving of simple problems based on dielectric, magnetic and conducting materials.
4. Impart knowledge of Nano-technology to electrical engineering.5. Demonstrate testing methods of dielectric, insulating, magnetic, conducting and resistive materials as per IS.
5. Enable students to create self learning resource material through active learning based on practical /case study/assignments.

Course Outcomes:

Upon successful completion of this course, the students will be able to :

CO1: Discuss classification,properties and characteristics of different electrical engineering materials.
CO2: State various applicationsmeasuring methods for parameters of different classes of electrical engineering materials.
CO3: Solve simple problems based on dielectric, magnetic and conducting materials.
CO4: Apply knowledge of Nano-technology to electrical engineering.
CO5: Execute tests ondielectric, insulating, magnetic, conducting, resistive materials as per IS to decide the quality of thematerials.
CO6: Create learning resource material ethically to demonstrate **self learning leading to** lifelong learning skills and usage of ICT/ online technology through collaborative/active learning activities.

Academic Activity Planner

Units	Unit Test1 (10marks)	MCQ (20marks)	Assignment (Each 20marks)	Unit Test3(50marks)
1	✓	✓		✓
2		✓		✓
3		✓		✓
4		✓		✓
5			✓	✓
6			✓	✓

PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

Teaching Plan

Teaching plan as per University Syllabus

Sr.No.	Unit	Broad Topics to be Covered	Total Lecture Planned
1	I	Unit 01 A] : Dielectric Properties of Insulating Materials:	6 Hrs
2	II	Unit 02 A] : Dielectric Breakdown: Unit 02 B] : Testing of Materials	6 Hrs
3	III	Unit 03 : Insulating Materials, Properties & Applications:	6 Hrs
4	IV	Unit 04 : Magnetic Materials:	6 Hrs
5	V	Unit 05 : Conducting Materials:	6 Hrs
6	VI	Unit 06 : Nanotechnology:	6 Hrs

Unit wise Lecture Plan

Unit No.-I: Dielectric Properties of Insulating Materials

Pre-requisites:- Students should have knowledge of various basic classiftcation of materials.

Objectives :-

- To classify different materials from Electrical Engineering application point of view.

Outcomes:-

Upon successful completion of this course, the students will be able to :-

- To classify different materials from Electrical Engineering application point of view.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Dielectric Properties of Insulating Materials: Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability]	T1,T3,R1,R3,R8,R10	Chalk & Talk/ Online Meet (Google Meet)
2	Introduction to Polar and Non- Polar dielectric materials		Chalk & Talk/ Online Meet (Google Meet)
3	Mechanisms of Polarizations-Electronic, Ionic and Orientation Polarization (descriptive treatment only),		Chalk & Talk/ Online Meet (Google Meet)
4	Clausius Mossotti Equation		Chalk & Talk/ Online Meet (Google Meet)
5	Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Concept of negative tan delta		Chalk & Talk/ Online Meet (Google Meet)
6	Dielectric loss and loss tangent,		Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

1) Describe polarisation process in detail.
2) Why & how does polarisation occures?
3) Explain ionic polarisation in detail.
4) How ionic polarisation is different from orientational polarisation?
5) Explain electronic polarisation.
6) Define following:
    a) Electric dipole moment
    b) Dielectric constant
    c) Electric flux density
    d) Electric susceptibility
    e) Polarizability
7) Explain following terms:
    a) Loss tangent
    b) Ferroelectricity
    c) Derive Clausious Moscotti equation.
8) Derive Clausious Moscotti equation.
9) Explain with diagram piezoelectric materials & its application.
10) What is negative tan delta?

Unit No.-II: Dielectric Breakdown

Pre-requisites:- Students should have knowledge of various classes of dielectric materials..

Objectives:- To understand various properties and characteristics of different classes of dielectric materials.

Outcomes:-After successfully completing this unit students will be able:

To understand various properties and characteristics of different classes of dielectric materials.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Dielectric Breakdown: Introduction, Concept of Primary and Secondary Ionization of Gases,Breakdown Voltage, Breakdown Strength,	T1,T4, R1,R3	Chalk & Talk/ Online Meet (Google Meet)
2	Concept of Primary and Secondary Ionization of Gases,Breakdown Voltage, Breakdown Strength		Chalk & Talk/ Online Meet (Google Meet)
3	Factors affecting Breakdown Strengths of Solid, Liquid dielectric materials.		Chalk & Talk/ Online Meet (Google Meet)
4	Factors affecting Breakdown Strengths of Gaseous dielectric materials.		Chalk & Talk/ Online Meet (Google Meet)
5	MCQ, numericals		Chalk & Talk/ Online Meet (Google Meet)
6	**Testing of Materials**		Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

Theory Paper

Unit 2

1) Describe between:
    a) Breakdown voltage & break down strength
    b) Primary & secondary ionisation
2) Expalin different types of electric discharges.
3) Explain tracking phenomenon in soild dielectric materials.
4) Explain treeing phenomenon in soild dielectric materials.
5) Explain the factors on which breakdown in gaseous insulating material depends.
6) Explain the factors on which breakdown in solid insulating material depends.
7) Explain the factors on which breakdown in liquid insulating material depends.
8) Explain Townsend's primary ionisation coefficient.
9) Explain Townsend's secondary ionisation coefficient.

Unit No.-III: Insulating Materials, Properties & Applications

Pre-requisites:- Students should have knowledge of various classes of materials..

Objectives:- To understand various properties and characteristics of different classes of materials.

Outcomes:-After successfully completing this unit students will be able:

To understand various properties and characteristics of different classes of materials.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Insulating Materials, Properties & Applications: Introduction, Characteristics of Good Insulating Material, Classification of solid, liquid gaseous materials	T1,T4, R1,R3	Chalk & Talk/ Online Meet (Google Meet)
2	Solid Insulating Materials-Paper, Press Board		Chalk & Talk/ Online Meet (Google Meet)
3	Fibrous Materials, Mica ,Mechanite,,		Chalk & Talk/ Online Meet (Google Meet)
4	Ceramics, Asbestos,Amorphous materials,		Chalk & Talk/ Online Meet (Google Meet)
5	Resins, Polymers, Enamels,Rubber..		Chalk & Talk/ Online Meet (Google Meet)
6	Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF6		Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

Theory Paper

Unit 3

Unit 02 A]: Insulating Materials, Properties & Applications:

1) What is impregnation process? Why it is necessary?
2) Explain inpregnation process for paper & cotton.
3) Write down properties & applications of:
   a) Paper
   b) Pressboard
   c) Fibrous materials
   d) Ceramics
   e) Asbestos
   f) Varnish
   g) Askarel
   h) Mica
   i) Mechanite
   j) Porcelain
4) State properties & applications of:
   a) Air
   b) SF6
   c) Transformer oil
   d) Varnishes
   e) Rubber
   f) Resins
5) Describe insulating materials used in:
   a) Capacitors
   b) Rotating machines
   c) Switchgears
   d) Line insulators
   e) Transformer
   f) Cables

Unit No.-IV: Magnetic Materials:

Pre-requisites :- Students should have knowledge of various classes of magnetic materials along with their basic characteristics.

Objectives :- To select materials for applications in various electrical equipment.

Outcomes:-After successfully completing this unit students will be able to:

To select materials for applications in various electrical equipment.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Magnetic Materials:** Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility,Magnetization], Classification of Magnetic Materials, Diamagnetism	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)
2	Paramagnetism , Ferromgnetism	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)
3	Ferri-magnetism, Ferro magnetic behavior below Critical Temperature,Spontaneous Magnetization, Curie-Weiss law	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)
4	Anti-ferromagnetism, Ferrites, MCQ, materials for Electric Devices such as Transformer Core ,Core of Rotating Machines	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)
5	Applications of Ferro-magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core ,Core of Rotating Machines	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)
6	Soft Magnetic Materials, Hard Magnetic Materials, Magnetic Recording Materials,	T1,R2, R3	Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

Theory Paper

Unit 03: Magnetic Materials:

1) Explain spontaneous magnetisation & Curie- Weiss law.
2) Write short note on:
    a) Magnetic recording materials
    b) Compact Discs
    c) Laser & magnetic strip technology
3) Differenciate between:
    a) Permeability & magnetic susceptibility.
    b) Soft & hard magnetic materials
4) Describe properties & applications of paramagnetic materials.
5) Explain:
    a) Premeability
    b) Magnetisation
    c) Curie temperature
    d) Magnetic Susceptibility
6) State properties & applications of hard magnetic materials.
7) Cassify magnetic material based on dipole moment. Explain each class w.r. to its applications & properties.
8) Write short note on behaviour of ferromagnetic materials below critical temperature.
9) What is anti-ferromagnetism?
10) Which magnetic materials are used for transformer core & core of rotating machines?

Unit No.-V: Conducting Materials

Pre-requisites:- Students should have knowledge of various classes of conducting , resistive materials along with their basic characteristics.

Objectives:- To select materials for applications in various electrical equipment.

Outcomes:-After successfully completing this unit students will be able to:

To select materials for applications in various electrical equipment.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Introduction to subject, syllabus,practicals & Conducting Materials	T1,,R1,R3	Chalk & Talk/ Online Meet (Google Meet)
2	General Properties of Conductor, Electrical Conducting Materials - Copper, & its applications		Chalk & Talk/ Online Meet (Google Meet)
3	Aluminum, steel, silver and its applications, classification of Materials of High & Low Resistivity-		Chalk & Talk/ Online Meet (Google Meet)
4	Constantan, Nickel-Chromium Alloy,Tungsten, Canthal,		Chalk & Talk/ Online Meet (Google Meet)
5	Silver & Silver alloys, Characteristics of Copper Alloys (Brass & Bronze),Materials used for Lamp Filaments		Chalk & Talk/ Online Meet (Google Meet)
6	Electrical Carbon Materials,Material used for Solders,Metals & Alloys for different types of Fuses, Transmission Lines,		Chalk & Talk/ Online Meet (Google Meet)
7	Materials for Super-capacitors,Introduction to Superconductivity and Super Conductors		Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

Theory Paper

Unit 04: Conducting Materials

1) State properties & applications of:
    a) Constantan
    b) Nickel-chromium alloy
    c) Tungsten
    d) Carbon
    e) Brass
    f) Bronze
    g) Platinum
    h) Mangnin
    i) Eureka
    j) Copper
    k) Aluminium
2) Describe materials used for:
    a) Lamp filaments
    b) Thermal bimetal
    c) Transmission lines
3) What are factors affecting resistivity of material.
4) Write short note on superconductivity.
5) What are thermocouples? Name 4 thermocouples with their applications.
6) What is seeback effect? Define Neutral temperature.
7) Explain peltier effect.
8) State & explain types of solders with their applications.
9) State & explain silver & silver alloy.
10) Why carbon is used for brushes of commutator machines.
11) State materials used for fuses.

Unit No.-VI: Nanotechnology Batteries

Pre-requisites:-. Students should have knowledge of basics of nanotechnology & types of batteries.

Objectives:- To impart knowledge of Nano-technology, battery and solar cell materials.

Outcomes:-After successfully completing this unit students will be able to:

To impart knowledge of Nano-technology, battery and solar cell materials.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	**Nanotechnology:** Introduction, Concepts of Energy bands & various Conducting Mechanism in Nano-structures,	T5,R9, R11	Chalk & Talk/ Online Meet (Google Meet)
2	Carbon Nano-structures		Chalk & Talk/ Online Meet (Google Meet)
3	Carbon Molecules, Carbon Clusters		Chalk & Talk/ Online Meet (Google Meet)
4	Carbon Nano-tubes andapplications.		Chalk & Talk/ Online Meet (Google Meet)
5	Special Topics in Nano Technology such as Single Electron Transistor		Chalk & Talk/ Online Meet (Google Meet)
6	Molecular Machines, BN Nanotubes, Nano wires.		Chalk & Talk/ Online Meet (Google Meet)

Question Bank: Theory

Theory Paper

Unit 05 : Nanotechnology:

1) With neat diagram describe:
    a) Carbon nano structures
    b) Carbon clusters
    c) Carbon nano tubes
    d) Nano wires
2) Write down applications of carbon nano tubes & BN nano tubes.
3) What do you mean by single electron transistor?
4) What do you mean by molecular machines?
5) Discuss briefly the energy bands in conductors, insulators, semiconductors.
6) Write short note on molecular machines.

ANALOG AND DIGITAL ELECTRONICS

Name of the Subject –Analog and Digital Electronics

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	03	-	02

Online/ In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	50	-	-	150	Th-03, Pr-01

Syllabus:

Unit01:Design of combinational circuit: (6hrs)
Booleans algebra, De-Morgan theory etc, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.

Unit02:Design of sequential circuit: (6hrs)
Introduction to sequential circuit. Design of synchronous (K-map) and asynchronous counters. Up down counters, modulo counters, Shift registers, ring and twisted ring counters

Unit03: Digital memories and logic families: (6hrs)
A) Digital memories: SRAM,DRAM,ROM,EPROM
B) Digital logic families: PAL,PLA,CPLD,FPGA

Unit04:Operational Amplifier Applications: (6hrs)
Open loop and close loop configuration of Op-Amp. Applications of Op- Amp- zero crossing detectors, Comparator, Schmitt trigger, V-I and I-V converters, Instrumentation amplifier, peak detector,WaveformgenerationusingOp-amp-sine,square,sawtoothandtriangulargenerator,

Unit05:OtherAnalogcircuits: (6hrs) Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation-astable and monostable multivibrators,Sequencegenerator,voltageregulatorsusingIC78xx,79xx,LM317

Unit06: Diode rectifier: (6hrs) Single phase half wave rectifier with R, RL loads. Single phase full wave rectifier-Center tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with Rload.

Text Books:

[T1] Floyd and Jain, "Digital Fundamentals", Pearson Education.
[T2] R. P. Jain, "Digital Electronics", Tata McGraw Hill, New Delhi.
[T3] Malvino, "Digital Computer Electronics- An Introduction to Microcomputers," Tata McGraw Hill.
[T4] Gaikwad R., "Operational Amplifier", PHI New Delhi.
[T5] Floyd, "Electronics Devices", Pearson Education.
[T6] Mottershed, "Electronics Devices & Circuits", PHI New Delhi
[T7] Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, Pearsons Education.

Reference Books:

[R1] Tokheim, "Digital Electronics-Principles and Application", 6th edition, Tata McGraw Hill, New Delhi.
[R2] A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Forth Edition.
[R3] K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.
[R4] James, "Operational Amplifier and Linear Integrated Circuits Theory and Application."
[R5] P John Paul, "Electronics Devices and circuits", New Age international Publications.
[R6] P. S. Bimbhra, "Power Electronics", Khanna Publications.

Unit	Text Books	Reference Books
1	T1, T2	R1
2	T1, T2, T3	R2
3	T4, T5	R3, R4
4	T4, T5	R3, R4
5	T5, T6	R5
6	T7	R6

Course Objectives

Course Objectives:

1)To use Kmap for Boolean algebra reduction and design digital circuit
2)To introduce digital memories and logical families.
3)To construct sequential and combinational circuits using flip-flops and Kmap
4)To develop the concept t of basics of operational Amplifier and its applications.
5)To design uncontrolled rectifier

Course Outcomes

Course Outcomes:

Upon successful completion of this course, the students will be able to :-

- CO1: Design logical, sequential and combinational digital circuit using-Map.
- CO2: Demonstrate different digital memories and programmable logic families.
- CO3: Apply and analyse applications of OPAMP in open and closed loop condition.
- CO4: Design uncontrolled rectifier with given specifications

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DEPARTMENT OF ELECTRICAL ENGINEERING

Academic Activity Planner

Units	MCQ TEST (10marks/ unit)	End Tem Test (30marks)
1	√	
2	√	
3	√	
4	√	
5		√
6		√

Teaching Plan

Teaching plan as per University Syllabus

Sr.No.	Unit	Broad Topics to be Covered	Total Lecture Planned
1	I	Booleans algebra, De-Morgan theory etc, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.	06
2	II	Introduction to sequential circuit. Design of synchronous (K-map) and asynchronous counters. Up downcounters,Nmodulocounters,Shiftregisters,ringandtwistedringcounters	06
3	III	A)Digitalmemories:SRAM,DRAM,ROM,EPROM B)Digitallogicfamilies:PAL,PLA,CPLD,FPGA	06
4	IV	Open loop and close loop configuration of Op-Amp. Applications of Op-Amp- zero crossing detectors, Comparator, Schmitt trigger, V-I and I-V converters, Instrumentation amplifier, peak detector,WaveformgenerationusingOp-amp-sine,square,sawtoothandtriangulargenerator	06
5	V	Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation- astable and monostablemultivibrators,Sequencegenerator,voltageregulatorsusingIC78xx ,79xx,LM317	06
6	VI	Single phase half wave rectifier with R, RL loads. Single phase full wave rectifier-Center tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with Rload.	06

Unit wise Lecture Plan

Unit No.-I: Number system & Boolean's Algebra.

Pre-requisites:- Basics of numbering system.

Objectives :-

- To demonstrate the concept of numbering system & Boolean's algebra reduction using K map.

Outcomes :

- Student will able to reduce Boolean expressions by K- Map.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Booleans algebra, De-Morgan theory etc, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.	T2, R1	Online mode
2	De-Morgan theory etc, Karnaugh map: structure for two	T2, R1	Online mode
3	De-Morgan theory etc, Karnaugh map: structure for three and four Variables,	T2, R1	Online mode
4	SOP form reduction of Boolean expressions by K-map	T2, R1	Online mode
5	POS form reduction of Boolean expressions by K-map	T2, R1	Online mode
6	Design of combinational circuits using Boolean expression and K-map	T2, R1	Online mode
7	encoder, decoder	T2, R1	Online mode
8	half and full adder.	T2, R1	Online mode
9	**RUBRICS**		

Question Bank: Theory

1. Define Gates.
2. List out the basic gates.
3. Define AND Gate.
4. What do you mean by logic circuit?
5. What do you mean by truth table?
6. Define variable.
7. Define OR Gate.
8. What do you mean by Boolean algebra?
9. List out the truth table entry for two input NAND Gate.
10. Define term.
11. Design a logic circuit for expression AB + C.
12. Define literals.
13. Define fundamental sums
14. What does the algebraic means of simplifying the Boolean expression misses?
15. How to obtain complement of a given expression.
16. What is the use of Boolean algebra?
17. What is Karnaugh Map method?
18. Explain using diagram how NOR and NAND Gates are Universal Gate.
19. Explain De Morgan's theorem using example.
20. Explain Identity, Complementation, Commutative, Associative and Distributive Laws with example.
21. Explain three variable Karnaugh map using example.
22. Explain Don't care condition using example.
23. Explain sum-of-products and product-of-sums.
24. Explain expanded form and canonical form of Boolean expression using example.
25. Show the logic circuit for Y = AB' + AB. Next simplify this Boolean equation and the corresponding circuit.
26. Show the logic circuit for this Boolean equation Y = (A'+B) · (A+B). Then, simplify the circuit s much as possible using algebra.
27. Obtain the simplified expression in sum of products for the following Boolean functions: xy + x'y'z' + x'yz'
    a) A'B + BC' + B'C'
    b) a'b' + bc + a'bc'
    c) xy'z + xyz' + x'yz + xyz
28. Convert the following sum-of-products Boolean expression into product-of-sums and vice versa.
    a. (A + B + C') · (A + B'+ C) · (A' + B + C) · (A' + B' + C')
    b. A · B + A' · B'
    c. A' · B'·C' + A' · B · C+ A · B · C' + A · B' · C
    d. (A + B') · (B' + C) · (B' + D)
29. Given the following truth table:

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

a) Obtain the simplified functions in sum of products
b) Obtain the simplified functions in product of sums

30. Design a sum-of-product and product-of-sum expression for the given truth table.

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

39. Simplify the following Boolean expressions:

    1. A · B · C + A · B · C' + A · B' · C+ A · B'· C' + A' · B · C + A' · B · C' + A'· B'· C' + A'· B'· C

    2. (A' + B + C') · (A' + B + C) · (C + D) · (C + D + E)

40. Minimize the Boolean function: F(A,B,C) = ∑ 0,1,3,5 + ∑ 2,7
41. Obtain the canonical form for the following
    F(A,B,C,D) = A · B' · C' + A · B · C · D + A' · B · C' · D + A' · B' · C' · D

    F(A,B,C,D) = (B + C' + D') (A' + B' + C + D) (A + B' + C' + D')

42. Obtain the simplified expressions in sum-of-products:
    F(x,y,z) =∑(2,3,6,7)

    F(A,B,C,D) =∑(7,13,14,15)

    F(A,B,C,D) = ∑(4,6,7,15)

    F(w,x,y,z) = ∑(2,3,12,13,14,15)

43. Obtain the simplified expressions in product-of-sums:
    F(x,y,z) =∏(0,1,4,5)

    F(A,B,C,D) =∏(0,1,2,3,4,10,11)

    F(w,x,y,z) = ∏(1,3,5,7,13,15)

44. The following Boolean expression BE + B'DE' is a simplified version of the expression A'BE + BCDE + BC'D'E + A'B'DE' + B'C'DE'. Are there any don't-care conditions? If so, what are they?
45. Prove the following expression
    A + A · B' + A · B' · C' + A · B'· C + C'·B · A = A
    [1 + L · M + L · M' + L' · M] · [(L + M') · (L' · M) + L' · M' (L + M)] = 0
46. Draw a Karnaugh map for the following truth tables. Then encircle all the octets, quads and pairs you can find.

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

47. Simplify the Boolean expression using Karnaugh map method.
F = X'YZ + X'YZ' + XY'Z' + XY'Z

F = X'YZ + XY'Z' + XYZ + XYZ'

Unit 02: Design of Sequential circuits:

Pre-requisites:-

Knowledge of basics of numbering system and basic electronic components.

Objectives:-

To design and analyze sequential and combinational circuits

Outcomes:-After successfully completing this unit students will be able:
Demonstrate basics of various types of Flip flops, design registers and counter.

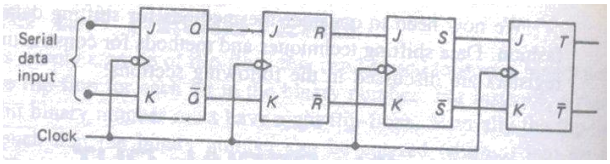
Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Concept of Combinational & Sequential circuits, Flip flops – R-S, Clocked S-R, D latches	T2, R1	Online : Google classroom
2	Edge triggered D flip-flops, Edge triggered JK flip flops, JK Master - slave flip flop	T2, R1	Online : Google classroom
3	Register-Buffer registers, shift registers (SISO,SIPO,PISO,PIPO)	T2, R1	Online : Google classroom
4	Controlled shift registers,	T2, R1	Online : Google classroom
5	Ring counter concept,	T2, R1	Online : Google classroom
6	Counters – asynchronous counters, synchronous counter	T2, R1	Online : Google classroom
7	Up-down Counter , Design of synchronous counter,	T2, R1	Online : Google classroom
8	Twisted ring counters, N – module counters.	T2, R1	Online : Google classroom
9	**RUBRICS**		

Question Bank: Theory
Theory Paper

Unit 2: Combinational & Sequential circuits

1. List the types of flip-flops.
2. Design a combinational circuit that accepts a three-bit number and generates an output binary number equal to the square of the input number.
3. List out the sequential circuit.
4. Draw block diagram of sequential circuit.
5. Define Flip Flop.
6. List two types of edge triggered flip-flops.
7. Draw a logic diagram of RS Flip-Flop with NAND gate.
8. Explain the four condition of RS Flip-Flop.
9. Draw a NOR implementation of RS Flip-Flop.
10. What do you mean by clock?
11. Define Propagation Delay.
12. What is the forbidden condition?
13. Draw a logic implementation of clocked RS Flip-Flop with its truth table.
14. What do you mean by Edge Triggered Flip-Flop?
15. What do you mean by Level Triggered Flip-Flop?
16. Give a logic implementation of positive edge triggered edge detector circuit.
17. What is race condition?
18. List several devices that are built using J-K flip-flop.
19. Give a logic implementation of J-K Flip-Flop with PRESET & CLEAR inputs.
20. Explain the four condition of RS Flip-Flop.
21. Draw a logic diagram of Toggle Flip-Flop using J-K Flip-Flop.
22. What is D Flip-Flop?
23. What do you mean by asynchronous inputs?
24. Classify flip-flop as synchronous or asynchronous.
25. List one type of asynchronous and three types of synchronous flip-flops.
26. List the different application of flip-flop.
27. Draw a truth table for following flip-flops J-K, D, RS ,Clocked Rs.
28. Draw a traditional logic symbols for the following flip-flops a) J-K b) D RS c) Clocked Rs.
29. Explain the Master-Slave Flip-Flop. How it overcome the race condition of J-K flip-flop. Use proper logic diagram.
30. Differentiate combinational and sequential circuits.
31. Differentiate synchronous or asynchronous inputs.
32. Differentiate level-triggered and edge-triggered flip-flops.
33. Give a brief note on edge triggered flip-flop using proper logic diagrams.
34. Explain J-K flip-flop with PRESET and CLEAR inputs using proper logic diagrams and truth tables.
35. Explain J-K flip-flop using proper logic diagrams and truth tables.
36. Explain R-S flip-flop using proper logic diagrams and truth tables.
37. Explain Toggle flip-flop using proper logic diagrams and truth tables.
38. Explain Clocked R-S flip-flop using proper logic diagrams and truth tables.
39. Explain Clocked D flip-flop using proper logic diagrams and truth tables
40. Explain two applications of flip-flops other than counters and registers.
41. Explain how D flip-flop can be used to detect the sequence of edges.
42. How we can say that J-K flip-flop is a universal flip-flop. Explain using logic diagrams.
43. What is a flip-flop? Show the logic implementation of R-S flip flop having active-High R and S inputs. Draw its truth table and mark the invalid entry.
44. What is a clocked J-K flip flop? What improvement does it have over a clocked R-S flip flop?
45. Differentiate D and T Flip Flop.
46. Briefly describes the following flip flop timing parameters: Set-up time and hold time, Propagation delay, Maximum clock frequency.
47. What do you mean by serial shifting?

48. Define modulus of counter.
49. Is counter is a sequential circuit or combinational circuit or sequential circuit with or without combination logic devices?
50. To shift 4 bit binary data out from SISO shift register what will be the input bits to a shift register?
51. What do you mean by modulus of counter?
52. Give the steps to design cascading decoder circuits. Also provide logic diagram.
53. Why asynchronous counters are also known as serial counters?
54. In what type of shift register complete binary number can be loaded into it in one operation and then have shifted out one bit at a time?
55. In what type of shift register data can be entered only one bit at a time but has all data bits available as outputs?
56. What are counters with arbitrary counts sequence?
57. Give at least one IC type number for four bit binary ripple counter.
58. Give at least one IC type number for four bit synchronous counter.
59. Give at least one IC type number for eight bit serial-in, serial-out shift register.
60. Give at least one IC type number for bidirectional universal shift register.
61. Define parallel counters. Draw the logic diagram for synchronous counter that count from 0000 to 1111. Explain how it counts the numbers.
62. Differentiate combinational circuits and sequential circuits.
63. Is PRESET & CLEAR are asynchronous inputs? Justify your answer.
64. Draw logic diagram for 4 bit Parallel In Parallel Out shift register and explain how it is used to shift data serially.
65. Draw the waveforms to shift the binary number 1010 into the register in Fig.1.



66. Name the four basic types of shift register, and draw a block diagram for each.
67. Differentiate between asynchronous and synchronous counter.
68. Differentiate between UP, DOWN and UP/DOWN counter.
69. Differentiate between Presentable and clearable counter.
70. Differentiate between BCD and Decade counter.
71. What is the difference between four-bit binary UP and four-bit binary DOWN counter?
72. How does architecture of an asynchronous UP counter differ from that of DOWN counter?
73. Why is maximum usable clock frequency in case of synchronous counter independent of that of size of counter?
74. What do you mean by shift register? Explain the Serial-In-Serial-Out shift register.
75. Design a Mod-10 counter. Also draw the timing waveforms.
76. Explain parallel counters. Give the circuit representation of 4-bit synchronous counter and explain its working.
77. What are counters with arbitrary counts sequence? Briefly describe the producers for designing a counter with a given arbitrary count sequence.

Unit No.-III: Digital memories and logic families:

Pre-requisites:-
Basic concepts of Logic Gates

Objectives :-

To introduce digital memories and logical families.

Outcomes:-After successfully completing this unit students will be able to:
Demonstrate different digital memories and programmable logic families.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Digital memories:SRAM,	**T2, R1**	Online : Google classroom
2	Digital memories: DRAM	**T2, R1**	Online : Google classroom
3	Digital memories: ROM	**T2, R1**	Online : Google classroom
4	Digital memories: EPROM	**T2, R1**	Online : Google classroom
5	Digital logic families :PAL	**T2, R1**	Online : Google classroom
6	Digital logic families: PLA	**T2, R1**	Online : Google classroom
7	Digital logic families: CPLD,FPGA	**T2, R1**	Online : Google classroom
9	**RUBRICS**		

Question Bank: Theory
Theory Paper
Unit No.-III

Q1 State any two advantages of a CMOS logic family.

Q2 Give the advantages of PAL over PLA.

Q3 Compare FPGA and CPLD .

Q4 . What does CPLD stand for? How is it different from the term PLD.

Q5. What are the types of PLD's.

Q6. Realize the following function using (i) PAL and (ii) PLA

$F(A,B,C,D) = \Sigma m(0,2,5,7,8,10,11,14)$.

Q7. Explain basic logic element of typical FPGA.

Unit No.-IV: Operational Amplifier Applications:

Pre-requisites:-

Basic concepts of Operational Amplifier

Objectives :-

- To develop the basics concept of operational Amplifier and its applications.

Outcomes:-After successfully completing this unit students will be able to:

- Analyze parameter of Op-amp and its applications.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Introduction to Op-Amp: Block diagrams of 741 and 324	T4, T7, R4, R6	Online : Google classroom
2	Ideal and practical parameters Op-Amp, Open loop and close loop configuration of Op-Amp.	T4, T7, R4, R6	Online : Google classroom
3	Derivation Of close loop voltage gain for non inverting amplifier and inverting	T4, T7, R4, R6	Online : Google classroom
4	Numericals on both inverting and non inverting amplifier, Adder, Subs tractor	T4, T7, R4, R6	Online : Google classroom
5	Integrator and differentiator	T4, T7, R4, R6	Online : Google classroom
6	Applications of Op- Amp- Comparator (Inverting and Noninverting)	T4, T7, R4, R6	Online : Google classroom
7	Schmitt trigger(Inverting and Non inverting)	T4, T7, R4, R6	Online : Google classroom
8	Instrumentation amplifier, zero crossing detectors ,	T4, T7, R4, R6	Online : Google classroom
9	V-I and I-V converters peak detector, Revision of Opamp	T4, T7, R4, R6	Online : Google classroom
10	**RUBERICS**		
11			
12	**FLIP LECTURE**		

Question Bank: Theory Paper: Unit No.-IV

Q.1 Draw the block diagram of operational amplifier and working of each block in brief. Comment on the parameters contributed by each stage.
Q.2. Define following parameters wrt Op-Amp :1 .Input offset voltage 2.Input Bias Current 3.Input Offset Current 4.Differential Voltage Gain 5.C.M.R.R. 6.Slew Rate 7.S.V.R.R. 8.Unity Gain Bandwidth
Q.3. State Ideal Characteristics of Op-Amp.
Q.4. Draw and explain Ideal Voltage Transfer Curve of Op-Amp.
Q.5. Explain the necessity of negative feedback in Op-Amp based amplifier circuits.
Q.6.What is thermal drift in operational amplifier? How does it affect the performance of an operational amplifier?
Q.7 Show how the effect of input bias current can be eliminated in case of Inverting and Non–Inverting Amplifiers.
Q.8 Show how can an operational amplifier be used as an adder?
Q.9 Discuss the use of an op-amp as a subtractor?
Q. 10 What do you understand by unity follower? Explain its gain term.
Q. 11. Explain how an operational amplifier can be used as an integrator?
Q. 12 Show the circuit diagram by which we obtain an output which is derivative of input?
Q. 13 What do you understand by filters? Give its classification
Q. 14 Define slew rate and state its significance?
Q. 15 Show how op-amp is used in closed loop configuration? What are its advantages?
Q. 16 Give the internal block diagram of op-amp and mention the role of each stage.
Q. 17 Give the pin-diagram of IC 741 and illustrate the concept of virtual ground.
Q. 18 Draw a non-inverting amplifier using op-amp and derive expression for its output voltage.
Q. 19 Draw the subtractor circuit using op-amp and mention its applications.
Q. 20. What do you understand by instrumentation amplifier?

Unit No.-V: Other Analog circuits

Pre-requisites:-

- Basics of Opamp

Objectives:-

- Learn to apply the basic knowledge of opamp.

Outcomes:-After successfully completing this unit students will be able to:

- Apply the knowledge of Op-amp as wave form generators & filters.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Waveform generation using Op-amp – sine, square	T4, T7,R4,R6	Chalk & Board
2	Opamp as Saw tooth and Triangular generator,	T4, T7,R4,R6	Chalk & Board
3	Active filters-Its configuration with frequency response	T4, T7,R4,R6	Chalk & Board
4	Analysis of first order low pass filters, Analysis of first order high pass filters	T4, T7,R4,R6	Chalk & Board
5	IC 555 –astable, monostable multivibrators	T4, T7,R4,R6	Chalk & Board
6	Sequence generator, Introduction to voltage regulators, Voltage regulator using ICs 78xx, 79xx	T4, T7,R4,R6	Chalk & Board
7	Voltage regulator using LM 317 and LM 723.	T4, T7,R4,R6	Chalk & Board
8	**RUBRICS**		
9			

Question Bank: Theory Paper: Unit No.-V

1. Explain the concept of virtual ground.
2. Draw the inverting and non-inverting amplifier with corresponding Input & output waveforms for the same What is a zero crossing detector?
3. Give any four applications of a comparator. 3. What is a voltage follower?
4. What is the need for an instrumentation amplifier?
5. State the requirements of instrumentation amplifier
6. What are the applications of V-I converter?
7. Draw the circuit diagram of I-V converter?
8. Give an application of an inverting amplifier.
9. What do you mean by a precision rectifier? Differentiate with conventional rectifier
10. Write down the applications of precision diode.
11. List the applications of Log amplifiers:
12. What are the limitations of the basic differentiator circuit?
13. Write down the condition for good differentiation and draw the circuit.
14. What is a comparator
15. Why active guard is necessary for instrumentation amplifier?
16. What are the applications of comparator?
17. What is a Schmitt trigger?
18. What do you understand by an Integrator?
19. What are the characteristics of a comparator?
20. What are the applications of comparator?
21. What is a multivibrator?
22. What do you mean by monostable multivibrator?
23. What is an astable multivibrator?
24. What is a bistable multivibrator?
25. Explain the working of a timer IC 555 as a monostable multivibrator with neat diagram and waveforms, Also derive expression for pulse width.
26. Draw transfer characteristics of PLL and explain.
27. Draw circuit using IC 555 for square wave generator and explain.
28. With neat diagram explain application of PLL as FM detector.
29. Explain the functions of the following pins of IC 555: a.Discharge b.Control Voltage c.Trigger
30. Draw circuit for a stable multivibrator using IC 555 and explain its operation.
31. What are the different types of filters?
32. Draw the pin diagram of 1. IC78XX 2. IC 79XX 3. IC LM723
33. State important features of IC 723.

Unit No.-VI

Unit No.-VI: Diode Rectifiers

Pre-requisites:-

Basic concepts of diode and rectifiers

Objectives: - To design uncontrolled rectifier

Outcomes:-After successfully completing this unit, students will be able to:

Design uncontrolled rectifier with given specifications.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Diode Rectifiers: Introduction	T4, T7,R4,R6	Online
2	Single phase half wave rectifier with R, RL load	T4, T7,R4,R6	Online
3	Single phase full wave rectifier Center tap rectifier supplying R and RL load	T4, T7,R4,R6	Online
4	Single phase full wave rectifier bridge rectifier supplying R and RL load	T4, T7,R4,R6	Online
5	Performance parameters. Numerical	T4, T7,R4,R6	Online
6	Three phase full wave bridge rectifier with R and RL load and RL load	T4, T7,R4,R6	Online
7	Comparison of single phase half wave and full wave rectifiers, Comparison of single phase full wave bridge and three phase full wave bridge rectifiers.	T4, T7,R4,R6	Online
8	Precision rectifiers: Half wave and Full wave.	T4, T7,R4,R6	Online
9	Comparison of diode and precision rectifier	T4, T7,R4,R6	Online
10	**RUBRICS**		

Question Bank: Theory
Theory Paper

1) Explain Ripple factor and Transformer utilization factor in half wave rectifier.
2) Describe Full wave Bridge Rectifier wit it's analysis..
3) Describe Half wave bridge rectifier
4) Draw the circuit diagram of half wave rectifier and explain its operation with the help of waveforms.
5) Derive the expressions for Ripple Factor and Efficiency of Half Wave Rectifier.
6) Derive the expressions for Average DC current, Average DC Voltage, RMS Value of Current, DC Power Output and AC Power Input of a Half Wave Rectifier.
7) Draw the circuit diagram of Full wave rectifier and explain its operation with the help of waveforms.
8) Derive the expressions for Ripple Factor and Efficiency of Full Wave Rectifier.
9) Derive the expressions for Average DC current, Average DC Voltage, RMS Value of Current, DC Power Output and AC Power Input of a Half Wave Rectifier.
10) A Half wave rectifier has a load of 3.5kΩ. If the diode resistance and the secondary coil Resistance together have resistance of 800Ω and the input voltage of 240V, Calculate
    (i) Peak, Average and RMS value of the current flowing,
    (ii) DC power output,
    (iii) AC Power input and
    (iv) efficiency of the rectifier.
11) With neat diagram, explain Bridge Rectifier.
12) Explain the operation of half wave rectifier with relevant circuit diagram and waveforms.
13) What are the disadvantages of half wave rectifier? How it is overcome?
14) Explain the operation of cetertap full wave rectifier with relevant circuit diagram and waveforms.
15) What are the disadvantages of center tap full wave rectifier? How it can be overcome?
16) Explain the operation of full wave bridge rectifier with relevant circuit and waveform.
17) Explain the operation of half wave rectifier with C filter using relevant circuit diagram waveforms and formulas.
18) Explain the operation of center tap full wave rectifier with C filter using relevant circuit diagram waveforms and formulas.
19) Explain the operation of bridge wave rectifier with C filter using relevant circuit diagram waveforms and formulas.
20) Design voltage regulator using zener diode.
21) Derive an expression for average load current and load voltage of half wave rectifier
22) Derive an expression for average load current and load voltage of center tap full wave rectifier
23) Derive an expression for average load current and load voltage of bridge wave rectifier
24) Derive an expression for RMS load current and RMS load voltage of half wave rectifier
25) Derive an expression for RMS load current and RMS load voltage of center tap full wave rectifier
26) Derive an expression for RMS load current and RMS load voltage of bridge wave rectifier
27) Evaluate ripple factor of a half wave rectifier.
28) Evaluate ripple factor of a center tap full wave rectifier
29) Evaluate ripple factor of a bridge wave rectifier.

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

Name of the Subject – Electrical Measurements and Instrumentation

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	03	-	04

Online/ In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	25	-	25	150	Th: 03 PR:02

Syllabus:

Unit 01 : **(9 Hrs)**

A. Classification of Measuring Instruments - Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog / digital.

Ammeter and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling and damping systems. Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) (attraction and repulsion), and Permanent Magnet Moving Coil (PMMC), block diagram and operation of digital ammeter & voltmeter.

B. Range Extension: PMMC ammeters and voltmeters using shunts, multipliers. Universal shunt, universal multiplier. Instrument Transformers : Construction, connection of CT & PT in the circuit, advantages of CT / PT over shunt and multipliers for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)

Unit 02 : **(8 Hrs)**

A. Measurement of Resistance: Measurement of low, medium and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, megger, loss of charge method. Earth tester for earth resistance measurement.

B. Measurement of Inductance: Introduction, sources and detectors for A.C. bridge, general equation for bridge at balance. Measurement of inductance: Maxwell's inductance & Maxwell's inductance – Capacitance Bridge, Anderson's bridge.

Unit 03 : **(8 Hrs)**

Measurement of Power: Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method. Power analyzer, Multi meter.

Unit 04 : **(7 Hrs)**

Measurement of Energy: Construction, working principle, torque equation, errors and adjustments of single phase conventional (induction type) energy meter. Calibration of energy meter. Block diagram and operation of electronic energy meter. Three phase energy meter, TOD meter.

Unit 05 : **(8 Hrs)**

A. **Oscilloscope:** Introduction, various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by lissajous pattern & numerical. Introduction to DSO.

B. **Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.
C. **Pressure Measurement:** Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure. High pressure measurement using electric methods, low pressure measurement by McLeod gauge and pirani gauge, capacitive pressure transducer.

Unit 06 : **(8 Hrs)**

A. Level Measurement: Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic and ultrasonic.
B. Displacement Measurement: LVDT & RVDT – construction, working, application, null voltage, specifications, advantages & disadvantages, effect of frequency on performance.
C. Strain Gauge: Introduction, definition of strain, types of strain gauge: Wire strain gauge, foil strain gauge, semiconductor strain gauge etc.; their construction, working, advantages and disadvantages.

Text Books:

[T1] A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation" Dhanpat Rai & Co.
[T2] J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation" S. K. Kataria & Sons,
[T3] R. K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers.
[T4] B. C. Nakra & K. K. Chaudhari, "Instrumentation Measurement and Analysis", Tata McGraw Hill.

Reference Books:

[R1] E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments" reem Publications.
[R2] Dr. Rajendra Prasad, Electronic Measurements & Instrumentation, Khanna Publishers
[R3] Arun K. Ghosh, "Introduction to Measurements and Instrumentation, PHI Publication
[R4] M. M. S. Anand "Electronics Instruments and Instrumentation Technology" by, PHI

Publication. **IS/IEEE Standards:**

1.IEEE Transactions on Instrumentation and Measurement (IEEE T INSTRUM MEAS).

Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

1.www.nptel.ac.in

2.www.electrical4you.com

3. www.electronicspani.com

Course Objectives

Course Objectives:

- To understand the necessity and importance of measurement and instrumentation.
- To know about various types of measurement techniques, instruments and sensors.
- To learn to apply proper methods of measurement and use of sensors in instrumentation.

Course Outcomes

Course Outcomes:

After successfully completing the course students will be able to:

CO 1	Understand various characteristics of measuring instruments, their classification and range extension technique.
CO 2	Classify resistance and apply measurement techniques for measurement of resistance and inductance.
CO 3	Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.
CO 4	Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures..
CO 5	Use CRO and DSO for measurement of various electrical parameters.
CO 6	Understand the characteristics of transducers and measure various physical parameters using transducers.

- **Academic Activity Planner**

Units	Test1 (10 marks each)	Test2 (10 marks each)	Assignment (Each 5 marks)	End Term Test3 (30marks)
1	√		√	
2	√		√	
3		√	√	
4		√	√	
5			√	√
6			√	√

Teaching Plan

Teaching plan as per University Syllabus

Sr.No.	Unit	Broad Topics to be Covered	Total Lecture Planned
1	I	A. Classification of Measuring Instruments B. Range Extension	7
2	II	A. Measurement of Resistance B. Measurement of Inductance	6
3	III	Measurement of Power	6
4	IV	Measurement of Energy	5
5	V	A. Oscilloscope B. Transducers C. Pressure Measurement:	6
6	VI	A. Level Measurement B. Displacement Measurement C. Strain Gauge	6

PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

Unit wise Lecture Plan

Unit No.-I: Classification of Measuring Instruments, Ammeter and Voltmeter Theory,Range Extension

Pre-requisites:- Basic concepts of ammeter, voltmeter and faraday's Law of EMI.

Objectives :-

- To understand different Measuring Instruments.
- To study the concept of Ammeter and Voltmeter Theory, Extension Range of Instruments.

Outcomes : Student can

- **Understand** various characteristics of measuring instruments, their classification and range extension technique **.**

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	A. Classification of Measuring Instruments: Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts.	T1,T2,T3,T4 R1,R2,R3,R4	PPT
2	Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog / digital.	T1,T2,T3,T4 R1,R2,R3,R4	PPT
3	Ammeter and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling and damping systems. Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) instruments –attraction type	T1,T2,T3,T4R1,R2,R3,R4	PPT
4	Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) instruments - repulsion type Block diagram and operation of digital ammeter & voltmeter	T1,T2,T3,T4R1,R2,R3,R4	PPT
5	B. Range Extension: Instrument Transformers : Construction, connection of CT & PT in the circuit	T1,T2,T3,T4R1,R2,R3,R4	PPT
6	Construction, connection of CT & PT in the circuit, advantages of CT / PT for range extension of MI Instruments,	T1,T2,T3,T4R1,R2,R3,R4	PPT
7	Transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)	T1,T2,T3,T4R1,R2,R3,R4	PPT

Question Bank: Theory- Unit :I

1. What do you mean by Static & Dynamic Characteristics of an Instrument? Explain the same.
2. Explain the classification of Instruments. Also What is the Calibration ?
3. Explain construction & working of following Instruments:
   Permanent Magnet Moving Coil (PMMC)
4. Which three forces are required for satisfactory operation of an Analog Indicating Instruments? State the function of each force in detail.
5. Explain the following terms related to Instrument Transformer:
   a)Transformation Ratio
   b)Nominal Ratio
   c)Burden
6. Explain construction & working principle of Potential Transformer
7. Explain construction & working of following Instruments:
   Moving Iron Type Instrument (MI)
8. What is meant by static and dynamic characteristics of measuring instruments ?
   Explain : Accuracy, resolution.
9. Describe the pointers & scales in indicating analog instruments.
10. Explain the phenomenon of Hysteresis in measurement systems also explain term Threshold,Maximum Input Hysteresis, Maximum output Hysteresis,Dead Zone & Backlash.Draw neat diagram.

Unit No.-II: Measurement of Resistance, Measurement of Inductance:

Pre-requisites:-

Knowledge about resistance, inductance, capacitance and impedance.

Objectives:-

To understand the necessity and importance of measurement and instrumentation
To know about various types of measurement techniques, instruments and sensors.

Outcomes:- After successfully completing this unit students will be able:
Classify resistance, apply measurement techniques for measurement of resistance, inductance.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Measurement of low, medium and high resistance, Ammeter-Voltmeter method , Wheatstone bridge	T1,T2, R1,R4	PPT
2	Kelvin's Double Bridge, Numerical on bridges	T1,T2 R1,R4	PPT
3	Megger, Earth tester for earth resistance measurement.	T1,T2 R1,R4	PPT
4	Measurement of Inductance: Introduction, Sources and detectors for A.C. bridge, General equation for bridge at balance, Maxwell's inductance	T1,T2 R1,R4	PPT
5	Maxwell's inductance – Capacitance Bridge and phasor diagram	T1,T2 R1,R4	PPT
6	Anderson's bridge and phasor diagram	T1,T2 R1,R4	PPT

Question Bank: Theory

Theory Paper

Unit 2:

1. Explain Earth Tester for measurement of Earth Resistance.
2. What are different detectors used in A. C. Bridges? Elaborate each type in brief. Derive general equation for bridge balance.
3. With a circuit diagram derive the equation for an unknown self inductance measurement using Maxwell's Inductance Bridge.
4. Draw circuit diagram of Kelvin's Double Bridge. Derive expression for unknown resistance with usual notations.
5. Draw circuit diagram & Explain Maxwell's Capacitance Bridge.
6. Draw circuit diagram & Explain Anderson's Bridge.
7. Explain Megger for measurement of high resistance with suitable diagram.
8. Draw circuit of Ammeter Voltmeter method for measurement of Low resistance.
9. Draw circuit diagram of Wheatstone bridge & Explain the same.
10. A Kelvin double bridge is balanced with the following constants: Outer ratio arm=100 Ω and 1000 Ω, Inner ratio arm= 99.92 Ω and 1000.6 Ω, Resistance of the link=0.1 Ω, Standard resistance =0.00377 Ω, Calculate the value of unknown resistance

Unit No.-III: Measurement of Power

Pre-requisites :-

Basic concepts of Power .

Objectives :-

To get the knowledge about the construction & operation of various Power Measurement Instruments

Outcomes:- After successfully completing this unit students will be able to:

Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Construction, working principle, torque equation.	**T1,T2** **R1,R2**	BB
2	Errors and their compensation, advantages/disadvantages of dynamometer type wattmeter	**T1,T2** **R1,R2**	BB,PPT
3	Low power factor wattmeter, Poly-phase wattmeter	**T1,T2** **R1,R2**	BB ,PPT
4	Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method,	**T1,T2** **R1,R2**	BB
5	Active & reactive power measurement using two wattmeter method	**T1,T2** **R1,R2**	BB
6	Active & reactive power measurement using one wattmeter method.	**T1,T2** **R1,R2**	BB

Question Bank: Theory

Theory Paper

Unit No.-III

1. Draw & explain the construction, working of dynamometer type wattmeter. Also derive its torque equation
2. State & explain errors in Electrodynamometer type wattmeter. Also state the compensation for each type of error.
3. With the help of circuit & phasor diagram explain reactive power measurement by One Wattmeter & Two way switch.
4. Explain two wattmeter method with circuit diagram & Vector diagram. Also state the effect of Power Factor on wattmeter reading.
5. Explain one wattmeter method with circuit diagram & Vector diagram for active and reactive Power Measurement.
6. Explain how two wattmeter can be used for three phase power measurement.
7. Draw & explain the construction, working of low power factor wattmeter.
8. List out the modifications has to be made in Dynamometer type wattmeter to make it Low Power Factor Meter
9. Draw & explain the construction, working of Poly-phase wattmeter.
10. Two wattmeters are connected to measure the power consumed by a 3-phase balanced load. One of the wattmeters read 1500 Ω and the other 700Ω. Find power factor of the load, when (a) both the readings are positive, and (b) when the reading of the second wattmeter is obtained after reversing its current coil connection.

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Unit No.-IV: Measurement of Energy

Pre-requisites:-

- Basic Concept of Electrical Energy.

Objectives:-

- To get knowledge about Construction & Working of Energy Meter.

Outcomes:- After successfully completing this unit students will be able to:

- Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Introduction and construction, working principle of (induction type) energy meter.	**T1,T2 R1,R2**	PPT
2	Torque equation of single phase conventional (induction type) energy meter.	**T1,T2 R1,R2**	PPT
3	Block diagram and operation of single phase	**T1,T2 R1,R2**	PPT
4	Three phase static energy meter	**T1,T2 R1,R2**	PPT
5	Calibration of static energy meter	**T1,T2 R1,R2**	PPT
6	TOD meter	**T1,T2 R1,R2**	PPT

Question Bank: Theory

Theory Paper

Unit No.-IV

1. Draw & explain the construction, working of Induction type Energy meter. Also Derive its Torque Equation.
2. Explain the errors in Energy Meter with compensation.
3. With block diagram explain working of Digital (Electronic) Energy Meter .State its Advantages.
4. Draw & explain the construction, working of TOD meter.
5. Explain How to calibrate The Energy Meter?
6. Draw and explain circuit diagram for calibration of single Phase Energy meter with different power factor.
7. What is Creep in Induction type Energy meter also describe its compensation.
8. Explain adjustments in Single Phase Energymeter to keep its errors within allowable limits.
9. Define (i) Energy meter constant (ii) Percentage error in Energy meter.
10. Discuss with block diagram, the principle of operation of single phase energy meter

Unit No.-V: A.**Oscilloscop** B. **Transducers:** C. **Pressure Measurement:**

Pre-requisites:- Knowledge about Electrical AC Circuits & Pressure.

Objectives:-

- To get the knowledge about the construction & operation of various electrical & non electrical measuring instruments.

Outcomes:-

- Use of CRO for measurement of various electrical parameters, importance of transducers, their classification, selection criterion and various applications.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Introduction, Oscilloscope, Various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency	**T1,T2,T3,T4 R2,R3,R4**	PPT
2	Phase angle & frequency by lissajous pattern, Introduction to DSO.	**T1,T2,T3,T4 R2,R3,R4**	PPT
3	Transducers: Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers	**T1,T2,T3,T4 R2,R3,R4**	PPT
4	Pressure Measurement: Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure.	**T1,T2,T3,T4 R2,R3,R4**	PPT
5	High pressure measurement using electric methods, low pressure measurement by McLeod gauge	**T1,T2,T3,T4 R2,R3,R4**	PPT
6	Pirani gauge, capacitive pressure transducer	**T1,T2,T3,T4 R2,R3,R4**	PPT

Question Bank: Theory
Theory Paper

Unit No.-V

1. Draw and Explain Block diagram of Cathode Ray Oscilloscope (CRO).
2. Explain the following terms associated with CRO
   I. Volts/div
   II. X-Y Mode
   III. Invert
3. Explain Voltage,Current & Frequency measurement with the help of CRO.
4. What is lissajous pattern. Explain how phase angle & frequency measured by lissajous pattern with examples.
5. List out the Classification of pressure and also write methods used for their measurement.
6. Explain measurement of Pressure using McLeod Gauge.
7. Explain Pirani Gauge for measurement of Low Pressure.Also State Advantages & Disadvantages
8. Explain Pressure Capacitance Transducer with neat diagram.Write Advantages & Disadvantages of Capacitive Transducer.
9. Define Transducer and state advantages of Electrical transducers.
10. Explain different characteristics of Transducer & their classification
11. Describe with neat sketches the following types of Primary Detecting Elements:a)Bourdon Tubes b)Bellows c)Diaphragms
12. Describe the different criteria for selection of transducer for particular application.

Unit No.-VI: Level Measurement: B. Displacement Measurement: C. Strain Gauge

Pre-requisites:-

Basic concepts of Physical parameter like Level,Displacement.

Objectives: -

To apply the knowledge to identify the measuring instruments & make use of it for quantifying measurements of electrical parameters.

Outcomes:- After successfully completing this unit, students will be able to:

Measurement of various physical parameters using transducers.

Lecture No.	Details of the Topic to be covered	References	Mode of Delivery
1	Introduction and importance of level measurement level measurement methods: mechanical, hydraulic, pneumatic	**T1,T2,T3 R2,R3**	PPT
2	Electrical, nucleonic and ultrasonic.	**T1,T2,T3 R2,R3**	PPT
3	LVDT & RVDT – construction, working, application specifications, advantages & disadvantages	**T1,T2,T3 R2,R3**	PPT
4	Effect of frequency on performance, Strain Gauge: Introduction, definition of strain	**T1,T2,T3 R2,R3**	PPT
5	Types of strain gauge: wire strain gauge, foil strain gauge their construction, working, advantages and disadvantages.	**T1,T2,T3 R2,R3**	PPT
6	Types of strain gauge: semiconductor strain gauge; their construction, working, advantages and disadvantages.	**T1,T2,T3 R2,R3**	PPT

Question Bank: Theory

Theory Paper

Unit No.-VI

1. Explain the construction, working of LVDT with neat diagram.
2. Explain Level measurement by Mechanical Method.
3. Explain the construction, working of RVDT with neat diagram.
4. Give types of Strain Gauges. Explain wire Strain Gauge with its advantages and disadvantages.
5. Explain Electrical methods of Level measurement.
6. Explain Level measurement using Ultrasonic Method.
7. Explain Foil strain gauge, also State Advantages & Disadvantages.
8. Explain semiconductor strain gauge, also State Advantages & Disadvantages.
9. Explain nucleonic method of level Measurement.
10. What is the definition and importance of primary sensing element?. Enlist some of the most commonly used primary sensing elements.