Progressive Education Society's

Modern College of Engineering, Shivajinagar, Pune – 05.

DEPARTMENT OF FIRST YEAR ENGINEERING
Curriculum Booklet

Year of Admission: 2020-21

Academic Year: 2020-21 Semester: I & II

Progressive Education Society's

Modern College of Engineering

DEPARTMENT OF FIRST YEAR ENGINEERING

Vision of the Institution:

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

Mission of the Institution:

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

Objectives of the Institution:

- To develop infrastructure appropriate for delivering quality education.
- To develop the overall personality of students who will be innovators and future leaders capable of prospering in their working environment.
- To inculcate ethical standards and make students aware of their social responsibilities.
- Promote close interaction among industry, faculty and students to enrich the learning process and enhance career opportunities.
- Encourage faculty in the continuous professional growth through quality enhancement programs and research and development activities.
- Foster a healthy work environment which allows for freedom of expression and protection of the rights of all stakeholders through open channels of communication.

Program Outcome

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

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

3. 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.

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

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

6. 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.

7. 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.

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

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

10. 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.

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

12. 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.

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Course Structure

Semester I

TABLE -1 First Engineering _Structure for Semester-I														
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		Theory	Practical	Tutorial	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
107001	Engineering Mathematics-I	03	--	01	30	70	25	--	--	125	03	--	01	04
107002/ 107009	Engineering Physics / Engineering Chemistry	04	02	--	30	70	--	25	--	125	04	01	--	05
102003	Systems in Mechanical Engineering	03	02	--	30	70	--	25	--	125	03	01	--	04
103004 / 104010	Basic Electrical Engineering / Basic Electronics Engineering	03	02	--	30	70	--	25	--	125	03	01	--	04
110005/ 101011	Programming and Problem Solving / Engineering Mechanics	03	02	--	30	70	--	25	--	125	03	01	--	04
111006	Workshop@	--	02	--	--	--	--	25	--	25	--	01	--	01
	Total	16	10	01	150	350	25	125	--	650	16	05	01	22
101007	Audit Course 1&	02	Environmental Studies-I											
Induction Program : 2 weeks at the beginning of semester-I and 1 week at the beginning of semester-II														

Semester II

TABLE -2 First Engineering_ Structure for Semester-II														
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		Theory	Practical	Tutorial	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
107008	Engineering Mathematics-II	04	--	01	30	70	25	--	--	125	04	--	01	05
107002/ 107009	Engineering Physics/ Engineering Chemistry	04	02	--	30	70	--	25	--	125	04	01	--	05
103004 / 104010	Basic Electrical Engineering / Basic Electronics Engineering	03	02	--	30	70	--	25	--	125	03	01	--	04
110005/ 101011	Programming and Problem Solving / Engineering Mechanics	03	02	--	30	70	--	25	--	125	03	01	--	04
102012	Engineering Graphics Ω	01	02	01	--	50	25		--	75	01	01		02
110013	Project Based Learning§	--	04	--	--	--	25	50	--	75	--	02	--	02
	Total	15	12	02	120	330	75	125	--	650	15	05	02	22
101014	Audit Course 2&	02	Environmental Studies-II											
107015		--	Physical Education-Exercise and Field Activities											

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Engineering Mathematics-I (Sem-I)

Course Title:FE All Branches **Engineering Mathematics - I**		**Course Number:** 107001	
Year:FE(ALL) AC.YR 2019-20		**Semester: I**	
Type of Course	Basic		
Teaching Scheme:3 Hrs/Week		**Tutorials:** 1 Hr/Week	
Course Assessment Method Examples	**Direct methods**	InsemExamination: 30 Marks	Theory Examination: 70 Marks
		Term-work 25 Marks	Practical/Oral: ----
	Indirect Methods	Tutorials,Assignments, Test, MCQs	
Course Prerequisites	Differentiation, Integration, Maxima and Minima, Determinants and Matrices		
Course Objectives	To make the students familiarize with concepts and techniques in Calculus, Fourier series and Matrices. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.		
Course Outcomes			
C101.1	Explain Mean value theorems and its generalizations leading to Taylors and Maclaurin's series.		
C101.2	Determine Fourier representation and Harmonic analysis of periodic continuous and discrete systems.		
C101.3	Apply Partial, Total derivatives and Jacobian in various engineering problems.		
C101.4	Use matrices in various engineering problems.		
Course Contents			
Unit-I	**Differential Calculus: (08 Hrs.)**		
	Rolle's Theorem, Mean Value Theorems, Taylor's Series and Maclaurin's Series, Expansion of functions using standard expansions, Indeterminate Forms, L' Hospital's Rule, Evaluation of Limits and Applications.		
Unit-II	**Fourier Series (08 Hrs.)**		
	Definition, Dirichlet's conditions, Full range Fourier series, Half range Fourier series, Harmonic analysis, Parseval's identity and Applications to problems in Engineerin		

Unit-III	**Partial Differentiation (08 Hrs.)**		
	Introduction to functions of several variables, Partial Derivatives, Euler's Theorem on Homogeneous functions, Partial derivative of Composite Function, Total Derivative, Change of Independent variables		
Unit-IV	**Applications of Partial Differentiation (08 Hrs.)**		
	Jacobian and its applications, Errors and Approximations, Maxima and Minima of functions of two variables, Lagrange's method of undetermined multipliers		
Unit- V	**Linear Algebra-Matrices, System of Linear Equations (08 Hrs.)**		
	Rank of a Matrix, System of Linear Equations, Linear Dependence and Independence, Linear and Orthogonal Transformations, Application to problems in Engineering.		
Unit-VI	**Linear Algebra-EigenValues and EigenVectors, Diagonalization (08 Hrs.)**		
	EigenValues and EigenVectors, Cayley Hamilton theorem, Diagonalization of a matrix, Reduction of Quadratic forms to Canonical form by Linear and Orthogonal transformations.		
Text Books	**Author**	**Title of Book**	**Publication & Edition**
T1	B. V. Ramana	Higher Engineering Mathematics	Tata McGraw Hill
T2	B. S. Grewal	Higher Engineering Mathematics	Khanna Publication, Delhi
Reference Books			
R1	P.N.Wartikar	Applied Mathematics (Volumes I& II)	Pune Vidyarthi GrihaPrakashan ,Pune
R2	Erwin Kreyszig	Advanced Engineering Mathematics	Wiley Eastern Ltd.
R3	M. D. Greenberg	Advanced Engineering Mathematics	Pearson Education
R4	Peter V. O'Neil	Advanced Engineering Mathematics	Thomson Learning
R5	Addison-Wesley, Pearson	Thomas' Calculus	Addison-Wesley, Pearson
R6	Ron Larson, David C. Falvo	Linear Algebra –An Introduction,	Cenage Learning, Indian edition
Contents beyond Syllabus	❖ Students are encouraged to do in-home assignments under the guidance of faculty. ❖ Special classes for students who are below average are arranged after the class hours.		

1.6 Question Bank

Unit 1:- Mean Value Theorem

1. Verify **Rolle's theorem** for the following functions:

i. $f(x) = e^{-x}\,(sinx - cosx)$ in $[\frac{\pi}{4}, \frac{5\pi}{4}]$.

ii. $f(x) = x(x-1)(x-2)$ in $[0,2]$.

iii. $f(x) = x(x+3)e^{\frac{-x}{2}}$ in $[-3,0]$.

iv. $f(x) = 2x^3 + x^2 - 4x - 2\ in\ [-\sqrt{2}, \sqrt{2}\,]$

v. $f(x) = \frac{sinx}{e^x}\ \ in\ \ [0, \pi\,]$

2. Verify **Lagrange's Mean Value Theorem** for the following functions:

i. $f(x) = lx^2 + mx + n$ in [a,b]

ii. $f(x) = x\ \ in\ [0,1]$

iii. $f(x) = x\ \ in\ [0,1]$

iv. $f(x) = \sqrt{x-1}$ in [1 , 3]

v. $f(x) = x + \frac{1}{x}\quad in\ [\frac{1}{2}, 2\,]$

vi. $f(x) = x\ logx\ in\ [1, e\,]$

vii. $f(x) = x(x-1)(x-2)$ in $[0\,, \frac{1}{2}]$

viii. $f(x) = \sqrt{x^2 - 4}$ in $[2, 3]$.

ix. $f(x) = x^2 + 3x + 3$, in $[1, 2]$.

x. $f(x) = \{x^2 - 3x\ x \leq 2\ x^3 - 11x + 12\ x > 2$ on [-1, 3

3. Prove that between any 2 real roots of $e^x sinx = 1$ there is at least one root of $e^x cosx + 1 = 0$

4. Prove that $logx < x < tanx$ for all $x > 1$.

5. Prove that $\frac{x}{1+x} < log(1+x) < x$ for all $x > 0$.

6. Prove that if 0 <a < b , $\frac{b-a}{1+b^2} < b - a\ \ < \frac{b-a}{1+a^2}$ and hence deduce that $\frac{\pi}{4} + \frac{3}{25} < \frac{4}{3} < \frac{\pi}{4} + \frac{1}{6}$

7. Prove that if a < 1 ,b < 1 and a < b ,then $\frac{b-a}{\sqrt{1-a^2}} < b - a < \frac{b-a}{1-b^2}$ and

hence show that $\frac{\pi}{6} - \frac{1}{2\sqrt{3}} << \frac{\pi}{6} - \frac{1}{\sqrt{15}}$

8. Show that $\frac{\pi}{3} - \frac{1}{5\sqrt{3}} > \left(\frac{3}{5}\right) > \frac{\pi}{3} - \frac{1}{8}$

9. Show that $\frac{b-a}{b} < log\left(\frac{b}{a}\right) < \frac{b-a}{a}$, where 0 < a < b

10. Using Lagrange's Mean Value Theorem , Prove if $x > 0\ x + 1\ ) = \frac{xe}{1+\theta x}$,where $0 < \theta < 1$.

11. Use Lagrange's MV Theorem to show that $sin\ sin\ (x+h)\ - sinx = h\ cosc\ \ , x < c < x + h$.

Indeterminate forms

1) Evaluate $\lim_{x\to 1}(1-x^2)^{\frac{1}{loglog\,(1-x)}}$

2) Evaluate $\lim_{x\to 0}\frac{xe^x - loglog\,(1+x)}{x^2}$

3) Evaluate $\lim_{x\to 0}(cot\ cot\ x\ )^{sinsin\ x}$

4) Evaluate $\lim_{x\to a}(x-a)^{(x-a)}$

5) Evaluate $\lim_{x\to \frac{\pi}{2}}(sec\ sec\ x - tan\ tan\ x\ )$

6) Evaluate $\lim_{x\to 0}\frac{e^{ax} - e^{-ax}}{loglog\,(1+bx)}$

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Finding unknowns if limiting value is given.

1) Find the values of a and b if

a) $\lim_{x\to 0} \frac{a\sinh\sinh x + b\sin x}{2x^3} = \frac{8}{6}$

b) $\lim_{x\to 0} \left[\frac{\sin\sin x}{x^3} + \frac{a}{x^2} + b\right] = 0$

c) $\lim_{x\to \infty} \left[\frac{a\cos\cos x - a + bx^2}{x^4}\right] = \frac{1}{12}$

d) $\lim_{x\to 0} [x^{-3} \sin\sin x + ax^{-2} + b\,] = 0$

e) $\frac{x(1+a\cos\cos x) - b\sin\sin x}{x^3}$ =1

f) $\frac{ax+bx}{x^4} = -\frac{1}{2}$

2) If $\lim_{x\to 0} \left[\frac{\sin\sin 2x + p\sin\sin x}{x^3}\right]$ is finite, find the value of p and hence evaluate the limit.

Expansions of functions by Taylor series

1) Expand $3x^3 - 2x^2 + x - 6$ in powers of $(x-2)$
2) Expand $2x^3 + 3x^2 - 8x + 7$ in powers of $(x-2)$
3) Expand $40 + 53(x-2) + 19(x-2)^2 + 2(x-2)^3$ in ascending powers of x
4) Expand $x^3 + 7x^2 + x - 6$ in powers of $(x-3)$
5) Expand $x^4 + 11x^3 + 42x^2 + 69x + 49$ in powers of $(x+2)$
6) Expand $2x^3 + 3x^2 - 8x + 7$ in powers of $(x-2)$
7) Expand $x^3 - 2x^2 + 3x + 1$ in powers of $(x-1)$

Examples of expansion

1) Prove that $x\cos ecx = 1 + \frac{x^2}{6} + \frac{7}{360}x^4 + \ldots\ldots$
2) Expand $\sqrt{1+\sin x}$ up to x^6.
3) Prove that extan x=x+x2+5x36+x42 +...
4) Show that $\log(1+\tan x) = x - \frac{x^2}{2} + \frac{2x^3}{3} - \ldots\ldots$
5) Show that $\log(1+\sin x) = x - \frac{x^2}{2} + \frac{x^3}{6} - \frac{x^4}{12} + \ldots\ldots$
6) Show that $e^x \cos\cos x = 1 + x + \frac{x^2}{2} - \frac{x^3}{3}$ ...
7) Expand $\{tan\ tan\ h\ log\ log\ x\ \}$.
8) Expand $(1+x)^{1/x}$ upto the term containing x^3
9) Prove that $\left\{\frac{\sqrt{1+x^2}-1}{x}\right\} = \frac{1}{2}\left[x - \frac{x^3}{3} + \frac{x^5}{5} + \cdots\right]$

Unit 2:- Fourier Series

1. Find the Fourier series for $f(x) = xsinx$ in the interval $0 \le x \le 2\pi$.
2. Find the Fourier series for $f(x) = x$ in the interval $0 \le x \le 2\pi$.
3. Find the Fourier series for $f(x) = x^2$ in the interval $0 \le x \le 2\pi$.
4. Find the Fourier series for $f(x) = x^3, -\pi < x < \pi$.
5. Find Fourier series to represent the function $f(x) = x \ \ in - \pi < x < \pi \ and \ f(x) = f(x + 2\pi)$.
6. Find Fourier series to represents the function $f(x) = \pi^2 - x^2, in \ -\pi \le x \le \pi$ and

   $f(x) = f(x + 2\pi)$.Deduce that $(i) \ \ \frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots = \frac{\pi^2}{12}$
7. Find Fourier series expansion for $f(x) = x^2$ in the interval $-l < x < l, \ f(x + 2l) = f(x), \forall x$.
8. Find Fourier series to represent the function $f(x) = x^2 - 2 \ \ in - 2 < x < 2$ and $f(x) = f(x + 4)$.
9. Obtain Fourier series for $f(x) = |x|, -\pi \le x \le \pi$.
10. $Find \ half - range \ cosine \ series \ for \ \ f(x) = x^2, 0 \le x \le \pi$
11. $Find \ half - range \ cosine \ series \ for \ \ f(x) = x^2, 0 \le x \le 2$
12. Find half range cosine for the function $F(x) = x - x^2, 0 \le x \le 1$.
13. Find half range cosine for the function $F(x) = sin^2 x, \ 0 < x < \pi$.
14. Find a half range cosine series of $F(x) = \pi x - x^2, 0 < x < \pi$.
15. Find the Fourier Expansion for y in term of x upto first harmonic as given in following table

x°	0	30	60	90	120	150	180	210	240	270	300	330
y	10.5	20.2	26.4	29.3	27	21.5	12.5	1.6	-19.2	-18.0	-15.8	-0.4

16. Obtain the first three coefficient in the Fourier Cosine series for y using practical harmonic

x	0	1	2	3	4	5
y	4	8	15	7	6	2

17. The turning moment T units of the crank shafts of a steam engine is given for a series of values of the crank angle θ in degrees.

θ	0	30	60	90	120	150	180
T	0	5224	8097	7850	5499	2626	0

Find the first four terms in a series of sines to represents T. Also calculate T when $\theta = 75^0$.

18. Obtain constant term and coefficients of the first sine and cosine terms in the Fourier expansion of y as given in the following table

x	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π	$\frac{4\pi}{3}$	$\frac{5\pi}{3}$
y	1.0	1.4	1.9	1.7	1.5	1.2

19. Obtain Fourier series of the following values upto second harmonic in the interval (0,6)

x	0	1	2	3	4	5	6
y	9	18	24	28	26	20	9

20. The turning moment T units of the crank shafts of a steam engine is given for a series of values of the crank angle θ in degrees.

θ	0	15	30	45	60	75	90	105	120	135	150	165	180
T	0	2.7	5.2	7.0	8.1	8.3	7.9	6.8	5.5	4.1	2.6	1.2	0

Expand T in a series of sines upto the second harmonic.

21. The following table gives variation of periodic current over a period

t sec	0	T/6	T/3	T/2	2T/3	5T/6	T
Aamp	1.98	1.30	1.05	1.30	-0.88	-0.25	1.98

Find the first harmonic.

Unit-3 : Partial Differentiation and Application

Partial Derivatives (Find n , variable to be treated as constant)

1. $If\ \ u = log\ log\ (x^3 + y^3 - x^2y - xy^2)$, prove that $\left(\frac{\partial}{\partial x} + \frac{\partial}{\partial y}\right)^2 u = \frac{-4}{(x+y)^2}$.
2. $If\ u = log\ log\ (x^3 + y^3 + z^3 - 3xyz)$, $prove\ that\ \left(\frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}\right)^2 u = \frac{-9}{(x+y+z)^2}$
3. $Prove\ that\ at\ the\ point\ of\ surface\ \ x^x.y^y.z^z = C\ where\ x = y = z\ \ \frac{\partial^2 z}{\partial x \partial y} = -(xlogex)^{-1}$
4. $If\ u = log(\sqrt{x^2 + y^2 + z^2})$, $then\ prove\ that\ (x^2 + y^2 + z^2)\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right) = 1$
5. $If\ u = r^m\ Where, r = \sqrt{x^2 + y^2 + z^2}\ then\ show\ that \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}) = m(m+1)r^{m-2}$.
6. $Verify\ \frac{\partial^2 u}{\partial x \partial y} = \frac{\partial^2 u}{\partial y \partial x}\ For\ u = \frac{y}{x}$.
7. $If\ x = u\ tanv, y = u\ secv, then\ prove\ that\ \left(\frac{\partial u}{\partial x}\right)_y \left(\frac{\partial v}{\partial x}\right)_y = \left(\frac{\partial u}{\partial y}\right)_x \left(\frac{\partial v}{\partial y}\right)_x$.
8. $Find\ n\ such\ that\ u = x^n(3y-1)\ \ satisfies\ \frac{\partial}{\partial x}\left(x^2 \frac{\partial u}{\partial x}\right) + \frac{1}{siny}\frac{\partial}{\partial y}\left(siny \frac{\partial u}{\partial y}\right) = 0.$
9. $If\ ux + vy = 0\ and\ \frac{u}{x} + \frac{v}{y} = 1\ then\ prove\ that\ \left(\frac{\partial u}{\partial x}\right)_y - \left(\frac{\partial v}{\partial y}\right)_x = \frac{x^2+y^2}{y^2-x^2}$
10. $If\ u = (x^2 - y^2)f(xy), then\ show\ that u_{xx} + u_{yy} = (x^4 - y^4)f''(xy)$
11. $Find\ the\ value\ of\ for\ which : z = Ae^{-gx}sin(nt - gx) satisfies\ the\ PDE : \frac{\partial z}{\partial t} = \frac{\partial^2 z}{\partial x^2}$.
12. $If\ u = tan(y + ax) + (y - ax)^{\frac{3}{2}}, where\ a\ is\ constant, then\ show\ that: \frac{\partial^2 u}{\partial x^2} = a\frac{\partial^2 u}{\partial y^2}$.
13. $If\ \ z = tan\ tan\ (y + ax)\ + (y - ax)^{3/2}\ \ find\ the\ value\ of\ \ \frac{\partial^2 z}{\partial x^2} - a^2\frac{\partial^2 z}{\partial y^2}$
14. $If\ u = mx + ny\ , v = nx -$
    $my, where\ m, n\ are\ constant, then\ find\ the\ valu\ of: \left(\frac{\partial u}{\partial x}\right)_y . \left(\frac{\partial y}{\partial v}\right)_x . \left(\frac{\partial x}{\partial u}\right)_v . \left(\frac{\partial v}{\partial y}\right)_u$
15. $If\ u = 4e^{-6x}sin[pt - 6x] satisfies\ the\ parial\ differntial\ equation \frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2,}\ then\ find\ p.$
16. $If\ u = 2x + 3y\ , v = 3x - 2y\ prove\ that\ (i)\left(\frac{\partial y}{\partial v}\right)_x \left(\frac{\partial v}{\partial y}\right)_u = \frac{13}{4}, (ii)\left(\frac{\partial u}{\partial x}\right)_y \left(\frac{\partial x}{\partial u}\right)_v = \frac{4}{13}$.
17. $If\ x = \frac{cos\theta}{u}, y = \frac{sinsin\ \theta}{v}\ \ then, evaluate\ \ \left(\frac{\partial x}{\partial u}\right)_\theta . \left(\frac{\partial u}{\partial x}\right)_y + \left(\frac{\partial y}{\partial u}\right)_\theta . \left(\frac{\partial u}{\partial y}\right)_x$
18. If $x = rcos\ \theta, y = r\ sin\ sin\ \theta,$ then prove that i) $\left(\frac{\partial y}{\partial r}\right)_x + \left(\frac{\partial y}{\partial r}\right)_\theta = 1,$ ii)$= \left(\frac{\partial x}{\partial \theta}\right)_r = \left(\frac{\partial \theta}{\partial x}\right)_y$
19. $If\ x = \frac{cos\theta}{r}, y = \frac{sinsin\ \theta}{r}\ \ then, evaluate\ \ \left(\frac{\partial x}{\partial r}\right)_\theta . \left(\frac{\partial r}{\partial x}\right)_y + \left(\frac{\partial y}{\partial r}\right)_\theta . \left(\frac{\partial r}{\partial y}\right)_x$
20. Find the value of n for which $z = t^n e^{-\frac{r^2}{4t}}$, satisfies the partial differential equation $\frac{1}{r^2}\left[\frac{\partial}{\partial r}\left(r^2 \frac{\partial z}{\partial r}\right)\right] = \frac{\partial z}{\partial t}$.

21. If $x^2 = a\sqrt{u} + b\sqrt{v}$ and $y^2 = a\sqrt{u} - b\sqrt{v}$ where a and b are constants , prove that $\left(\frac{\partial u}{\partial x}\right)_y \left(\frac{\partial x}{\partial u}\right)_v = \frac{1}{2}\left(\frac{\partial v}{\partial y}\right)_x \left(\frac{\partial y}{\partial v}\right)_u$.
22. If $z^3 - xz - y = 0$, then prove that $\frac{\partial^2 z}{\partial x \partial y} = -\frac{3z^2+x}{(3z^2-x)^3}$.
23. *If* $u = 2x + 3y$, $v = 3x - 2y$, *then find the value of*: $\left(\frac{\partial u}{\partial x}\right)_y . \left(\frac{\partial y}{\partial v}\right)_x . \left(\frac{\partial x}{\partial u}\right)_v . \left(\frac{\partial v}{\partial y}\right)_u$
24. If $z^3 - zx - y = 4$ *find* $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$.
25. If $x = \frac{r}{2}\left[e^{\theta} - e^{-\theta}\right]$ *and* $y = \frac{r}{2}\left[e^{\theta} + e^{-\theta}\right]$ *Prove that* $\left(\frac{\partial x}{\partial r}\right)_\theta = \left(\frac{\partial r}{\partial x}\right)_y$.
26. *If* $x^2 = au + bv$ *and* $y^2 = au - bv$ *then prove that* $\left(\frac{\partial u}{\partial x}\right)_y . \left(\frac{\partial x}{\partial u}\right)_v = \left(\frac{\partial v}{\partial y}\right)_x . \left(\frac{\partial y}{\partial v}\right)_u$
27. *If* $u = log\ log\ (x^3 + y^3 - x^2y - xy^2)$, prove that $\left(\frac{\partial}{\partial x} + \frac{\partial}{\partial y}\right)^3 u = \frac{16}{(x+y)^2}$
28. If $z^3 - xz - y = 4$, then find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$

Euler's Theorem

1. *If* $u = sin\ sin\left(\sqrt{x} + \sqrt{y}\right)$ *then prove that* $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \frac{1}{2}\left(\sqrt{x} + \sqrt{y}\right) cos\ cos\left(\sqrt{x} + \sqrt{y}\right)$.
2. *If* $u = \frac{x^3+y^3}{y\sqrt{x}} + \frac{1}{x^7}\left(\frac{x^2+y^2}{2xy}\right)$ *then find the value of* $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$ *at point* (1,1).
3. *If* $u = x^8 \emptyset\left(\frac{y}{x}\right) + \frac{1}{y^8}\emptyset\left(\frac{x}{y}\right)$ *then prove that* $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 64u$
4. *If* $u = \left(\frac{x^3y^2+4y^3x^2}{\sqrt{x^4+6y^4}}\right)$ *Find the value of* $(i)x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ $(ii)x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$.
5. *If* $u = log\ log\ (x^3 + y^3 - x^2y - xy^2)$ *then prove that* $x^2u_{xx} + 2xyu_{xy} + y^2u_{yy} = -3$.
6. *If* $u = cos\left(\frac{xy}{x^2+y^2}\right) + \sqrt{x^2+y^2} + \frac{xy^2}{x+y}$, *then find the value of* $xu_x + yu_y$ *at* (3,4).
7. *If* $u = \frac{x^4+y^4}{x^2y^2} + x^6\left(\frac{x^2+y^2}{x^2+2xy}\right)$ *Find the valu of*: $x^2\frac{\partial^2 y}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ *at* $x = 1$, $y = 2$
8. *If* $u = \sqrt{\frac{x^2+y^2}{x+y}}$ *Show that* $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = \frac{1}{4}\ tanu[u\ - 1]$
9. *If* $u = x^3 f\left(\frac{y}{x}\right) + \frac{1}{y^3}\emptyset\left(\frac{x}{y}\right)$, *prove that*: $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 9$
10. *If* $z = f(u, v)$ *and* u, v *are homogeneous functions in* x, y *of degree* 10 *of each, then* prove that $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = 10\left(u\frac{\partial z}{\partial u} + v\frac{\partial z}{\partial v}\right)$
11. If $u = cosec^{-1}\left(\frac{\sqrt{x^{\frac{1}{2}}+y^{\frac{1}{2}}}}{\sqrt{x^{\frac{1}{3}}+y^{\frac{1}{3}}}}\right)$, ten show that $x^2u_{xx} + 2xyu_{xy} + y^2u_{yy} = \frac{tantan\,u}{12}\left(\frac{13}{12} + \frac{u}{12}\right)$.
12. If $u = (\sqrt{x^2 + y^2}\ )$ then prove that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = u$.
13. Verify Eulers theorem for homogeneous functions $F(x, y, z) = 3x^2yz + 5xy^2z + 4z^4$

14. If $u = \left[\frac{x^3+y^3}{x+y}\right]$, then prove that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = sin\ sin\ 2u\ [1 - 4u\ ]$

15. $If\ z = x^8 f\left(\frac{y}{x}\right) + y^{-8}\emptyset\left(\frac{x}{y}\right)\ then\ prove\ that\ \ x^2\frac{\partial^2 z}{\partial x^2} + 2xy\frac{\partial^2 z}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = 64z + 8y^{-8}\emptyset\left(\frac{x}{y}\right) - 8x^8 f\left(\frac{y}{x}\right)$,

16. If $u\left[\frac{x+y}{\sqrt{x}+\sqrt{y}}\right]$ prove that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = -\frac{1}{4}cotu[3 + cot^2 u]$.

17. If $u = \frac{\sqrt{x^7+y^7}}{3\sqrt{x^4+y^4}} + cos\ cos\ \left[\frac{xy+y^2}{4xy}\right] + log\ log\ \frac{x}{y}$, then find the value of $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$

18. If $u\left[\frac{\sqrt{x^3+y^3}}{\sqrt{x}+\sqrt{y}}\right]$, then prove that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = -\ sin\ sin\ 2uu$.

19. If $T = sin\ sin\ \left(\frac{xy}{x^2+y^2}\right) + \sqrt{x^2+y^2} + \frac{x^2 y}{x+y}$, find the value of $x\frac{\partial T}{\partial x} + y\frac{\partial T}{\partial y}$.

20. If $u\left[\frac{\sqrt{x^3+y^3}}{\sqrt{x}+\sqrt{y}}\right]$, then prove that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = -2u\ cos\ cos\ u$

21. $If\ u = \frac{x^3+y^3}{x+y} + \frac{1}{x^5}\left(\frac{x^2+y^2}{x^2+2xy}\right) then\ find\ the\ value\ of\ x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}\ at\ point\ (1,2)$.

22. If $u = \frac{xyz}{2x+y+z} + log\left(\frac{x^2+y^2+z^2}{xy+yz}\right)$, find $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z}$.

23. $If\ \ u = (x^2+y^2)^{1/5}\ \ then\ prove\ that\ \ x^2 u_{xx} + 2xy\, u_{xy} + y^2 u_{yy} = \frac{2}{5}tan\ tan\ u\ \left[\frac{2}{5}u\ - \frac{3}{5}\right]$

24. $If\ \ f(x,y) = \frac{1}{x^2} + \frac{1}{xy} + \frac{log\,log\,x - log\,log\,y}{x^2+y^2}\ \ then\ prove\ that\ \ x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y} + 2f = 0$

25. $If\ \ x = e^u\ tan\ tan\ v\ , y = e^u\ sec\ sec\ v\ , find\ the\ value\ of\ \ \left(x\ \frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}\right)\left(x\ \frac{\partial v}{\partial x} + y\frac{\partial v}{\partial y}\right)$

Composite Function, Chain rule

1. $If\ u = x^2 - y^2, v = 2xy\ and\ z = F(u,v), then\ show\ that\ x\frac{\partial z}{\partial x} - y\frac{\partial z}{\partial y} = 2\sqrt{u^2+v^2}\frac{\partial z}{\partial u}$.
2. $If\ z = F(x,y), where\ x = e^u cosv, y = e^u sinv\ then\ prove\ that: y\frac{\partial z}{\partial u} + x\frac{\partial z}{\partial v} = e^{2u}\frac{\partial z}{\partial y}$.
3. $If\ u = F\left(\frac{x}{y}, \frac{y}{z}, \frac{z}{x}\right)\ \ prove\ that\ \ x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z} = 0$
4. $If\ f(x,y) = 0, \emptyset(x,z) = 0\ the\ prove\ that\ \frac{\partial \emptyset}{\partial x}\frac{\partial f}{\partial y}\frac{\partial y}{\partial z} = \frac{\partial f}{\partial x}\frac{\partial \emptyset}{\partial z}$
5. $If\ z = F(u,v) and\ u = log(x^2+y^2), v = \frac{y}{x} show\ that: x\frac{\partial z}{\partial y} - y\frac{\partial z}{\partial x} = (1+v^2)\frac{\partial z}{\partial v}$.
6. If $z = f(u,v)\ where\ \ u = xcost - ysint,\ \ v = x\ sint + ycost$ here t is a constant, then prove that $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = u\frac{\partial z}{\partial u} + v\frac{\partial z}{\partial v}$.
7. $If\ u = f(x-y, y-z, z-x), thenfind\ the\ value\ of: \frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z}$.
8. $If\ z = f(x,y), x = \frac{cosu}{v}, y = \frac{sinu}{v}, then\ prove\ that\ v\frac{\partial z}{\partial v} - \frac{\partial z}{\partial u} = (y-x)\frac{\partial z}{\partial x} - (y+x)\frac{\partial z}{\partial y}$
9. $If\ u = f(r,s), r = x^2+y^2, s = x^2-y^2 prove\ that\ \ y\frac{\partial u}{\partial x} + x\frac{\partial u}{\partial y} = 4xy\frac{\partial u}{\partial r}$.

10. $If\ z = f(x,y), where\ x = ucos \propto + vsin \propto, y = usin \propto - vcos \propto where \propto is\ constant, show\ that:$
$\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial u}\right)^2 + \left(\frac{\partial z}{\partial v}\right)^2$
11. If $x = rcos\ \theta, y = r\ sin\ sin\ \theta,$ where r and θ are functions of t, then prove that $x\frac{dy}{dt} - y\frac{dx}{dt} = r^2\frac{d\theta}{dt}$.
12. If $z = f(x,y)$ and $x = rcos\ h\theta, y = rsin\ h\theta$ then show that $(x-y)(z_x - z_y) = rz_r - z_\theta$
13. If $x = u + v + w, y = uv + vw + uw, z = uvw$ and F is function of x, y, z then prove that that
$x\frac{\partial F}{\partial x} + 2y\frac{\partial F}{\partial y} + 3z\frac{\partial F}{\partial z} = u\frac{\partial F}{\partial u} + v\frac{\partial F}{\partial v} + w\frac{\partial F}{\partial w}$
14. If $x = \frac{coscos\ \theta}{u}, y = \frac{sinsin\ \theta}{u}$, then prove that $u\frac{\partial z}{\partial u} - \frac{\partial z}{\partial \theta} = (y-x)\frac{\partial z}{\partial x} - (y+x)\frac{\partial z}{\partial y}$
15. If $u = f(2x-3y, 3y-4z, 4z-2x)$,then find the value of $\frac{1}{2}\frac{\partial u}{\partial x} + \frac{1}{3}\frac{\partial u}{\partial y} + \frac{1}{4}\frac{\partial u}{\partial z}$.
16. If $\emptyset = f(x,y,z), x = \sqrt{vw}, y = \sqrt{uw}, z = \sqrt{uv},$ prove that $x\frac{\partial \phi}{\partial x} + y\frac{\partial \phi}{\partial y} + z\frac{\partial \phi}{\partial z} = u\frac{\partial \phi}{\partial u} + v\frac{\partial \phi}{\partial v} + w\frac{\partial \phi}{\partial w}$
17. If $u = x^2 - y^2, v = 2xy$ and $z = f(x,y)$ then show that $x\frac{\partial z}{\partial x} - y\frac{\partial z}{\partial y} = 2\sqrt{u^2+v^2}\frac{\partial z}{\partial u}$.
18. If $z = f(u,v)$, where $u = x^2 - 2xy - y^2$ and $v = y$ then show that $(x+y)\frac{\partial z}{\partial x} + (x-y)\frac{\partial z}{\partial y} = (x-y)\frac{\partial z}{\partial v}$.
19. If $z = f(x,y)\ where\ x = u + v, y = uv$ then prove that $u\frac{\partial z}{\partial u} + v\frac{\partial z}{\partial v} = x\frac{\partial z}{\partial x} + 2y\frac{\partial z}{\partial y}$.
20. Find $\frac{dz}{dx}\ if\ z = x^2y\ and\ x^2 + xy + y^2 = 1.$
21. $If\ u = f(r), where\ r = \sqrt{x^2+y^2}\ then\ prove\ that\ u_{xx} + u_{yy} = f''(r) + \frac{1}{r}f'(r).$
22. $If\ z = f(x,y)\ where\ x = e^u\ cos\ cos\ v\ and\ y = e^u\ sin\ sin\ v\ then\ prove\ that\ y\frac{\partial z}{\partial u} + x\frac{\partial z}{\partial v} = e^{2u}\frac{\partial z}{\partial y}$
23. $If\ v = f(e^{x-y}, e^{y-z}, e^{z-x})\ then\ prove\ that\ \frac{\partial v}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial v}{\partial z} = 0$
24. $Find\ \frac{du}{dx}\ if\ u = x\ log\ log\ xy\ and\ x^3 + y^3 + 3xy = 0.$

UNIT:4. APPLICATION OF PARTIAL DIFFERENTIATION (M-I)

Jacobian

1. If $u = x(1-y)$and $v = xy$ find $\frac{\partial(x,y)}{\partial(u,v)}$.
2. If $x = uv$ and $y = \frac{u+v}{u-v}$, find $\frac{\partial(u,v)}{\partial(x,y)}$.
3. If $x = v^2 + w^2, y = w^2 + u^2, z = u^2 + v^2$, find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$.
4. If $x = u^2 - v^2, y = uv$, find $\frac{\partial u}{\partial x}$.
5. If $x = u + v, y = v^2 + w^2. z = w^3 + u^3$, show that $\frac{\partial u}{\partial x} = \frac{vw}{vw+u^2}$
6. If $u^3 + v^3 = x + y, u^2 + v^2 = x^3 + y^3$, find $\frac{\partial(u,v)}{\partial(x,y)}$.

7. If $u^2 + xv^2 = x + y$ and $v^2 + yu^2 = x - y$ find $\frac{\partial v}{\partial y}$.
8. If $u^2 + xv^2 - uxy = 0, v^2 - xy^2 + 2uv + u^2 = 0$, find $\frac{\partial u}{\partial x}$ by choosing u, v as dependent and x, y as independent variables.
9. If $u^2 + xv^2 - uxy = 0$ and $v^2 - xy^2 + 2uv + u^2 = 0$ fine $\left(\frac{\partial u}{\partial x}\right)_y$.
10. If $x = cos\ cos\ \theta\ - r\ sin\ sin\ \theta$ and $y = sin\ sin\ \theta\ + r\ cos\ cos\ \theta$ find $\frac{\partial r}{\partial x}$.
11. If $x = r\ sin\ sin\ \theta\ cos\ cos\ \phi\ , y = r\ sin\ sin\ \theta\ sin\ sin\ \phi\ , z = r\ cos\ cos\ \theta$ find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$
12. If $u + v^2 = x\ , v + w^2 = y, w + u^2 = z$ find $\frac{\partial u}{\partial x}$
13. If$x = rcos\theta\ , y = rsin\theta$,show that JJ' = 1
14. If$u + v = x^2 + y^2\ , u - v = x + 2y$ find $\frac{\partial u}{\partial x}$ treating y constant
15. If$x = v^2 + w^2, y = w^2 + u^2, z = u^2 + v^2$ prove that JJ' = 1
16. If $ux + vy = a, \frac{u}{x} + \frac{v}{y} = 1\ , prove\ that\ \left(\frac{\partial u}{\partial x}\right)_y - \left(\frac{\partial v}{\partial y}\right)_x = \frac{x^2+y^2}{y^2-x^2}$
17. If$u = x + y^2, v = y + z^2\ , w = z + x^2$ find $\frac{\partial x}{\partial u}$.
18. If $ux + vy = 0, \frac{u}{x} + \frac{v}{y} = 1$then using jacobian find $\left(\frac{\partial u}{\partial x}\right)_y$.
19. $If\ x = uv\ and\ \ y = \frac{u+v}{u-v}, find\ \frac{\partial(u,v)}{\partial(x,y)}$
20. $If\ \ u = x + y + z\ , v = x^2 + y^2 + z^2\ , w = x^3 + y^3 + z^3, find\ \frac{\partial x}{\partial u}$
21. If $ux = yz, vy = zx, wz = xy$, find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$.

Functional Dependence and Independence

Verify whether given functions are functionally dependent. If so, find the relation between them.

1. $u = \sin^{-1}x + \sin^{-1}y$, $v = x\sqrt{1-y^2} + y\sqrt{1-x^2}$
2. $u = x + y + z$, $v = x^2 + y^2 + z^2$, $w = x^3 + y^3 + z^3 - 3xyz$
3. u=y+z , v=x+2z2, w=x-4yz-2z2
4. $u = \frac{x}{y-z}\ v = \frac{y}{z-x}\ w = \frac{z}{x-y}$
5. $u = \frac{x+y}{1-xy}$, $v = \tan^{-1}x + \tan^{-1}y$

6. $u = \dfrac{x-y}{x+z}$ $v = \dfrac{x+z}{y+z}$
7. $u = \dfrac{y-x}{1+xy}$, $v = \tan^{-1} y - \tan^{-1} x$
8. u=sin x+sin y, v=sin (x+y)
9. $u = x + y + z$, $v = x^2 + y^2 + z^2$, $w = xy + yz + zx.$

Maxima Minima

1. Find extreme values of $f(x,y) = xy(a-x-y), x > 0, y > 0, a > 0.$
2. Find extreme values of $f(x,y) = x^3 + y^3 - 3axy. a > 0.$
3. Examine for maxima and minima of the function and find their extreme values$x^2 + y^2 + 6x + 12$
4. As dimensions of a triangle ABC are varied , show that the maximum value of $cosAcosBcosC$ is obtained when triangle is equilateral.
5. Find the minimum value of $x^2 + y^2$, subject to the condition $ax + by = c$
6. Find the stationary values of $f(x,y) = x^3y^2(\,1 - x - y\,)$ find f_{max} where it exists.
7. Find the stationary value of $u = x^m y^n z^n$ under the condition $x + y + z = a$.
8. Find extreme values of $f(x,y) = 3x^2 - y^2 + x^3.$

Lagrange'sMethod of undetermined Multiplier

1. Use Lagrange's method to find the minimum distance from origin to the plane $3x + 2y + z = 12.$
2. .
3. Using Lagrange's method divides 24 into three parts such that the continued product of the first, square of the second and cube of the third may be maximum.
4. Find the stationary points for the function $T(x,y,z) = 8x^2 + 4yz - 16z + 600$ if the condition $4x^2 + y^2 + z^2 = 16$ is satisfied

5. Find max and min distances of the point (3,4,12) from sphere $x^2 + y^2 + z^2 = 1$, usingLagrange's Method**.**
6. Divide 120 into three parts so that sum of product taken two at a time will be maximum.
7. Find the stationary values of$a^3x^2 + b^3y^2 + c^3z^2$where $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1$

Errors and apporximations

1. The resonant frequency in a series electrical circuit is given by $= \frac{1}{2\pi\sqrt{LC}}$. If the measurement in L and C are in error by 2 % and -1 % respectively. Find the percentage error in f.

2. The Resistance R of a circuit was calculated using the formula $I = ER$. If there is an error of 0.1 Amp in regarding I and 0.5 volts in E , find corresponding percentage error in R when I= 15 Amp and E=100 volts.
3. If $e^z = sec\ sec\ x\ cos\ cos\ y$ and errors of magnitude h and –h are made in estimating x and y where x and y are found to be $\frac{\pi}{3}$ and $\frac{\pi}{6}$ respectively . Find the corresponding error in z
4. In calculating the volume of a right circular cone error of 2% and 1% are found in measuring height and base radius respectively. Find the percentage error in calculating the volume.
5. A ballon is in the form of right circular cylinder of radius 1.5 m and length 4m and is surrounded by hemispherical ends. If the radius is increased by 0.01 m and the length by 0.05m , find the percentage change in the volume of a ballon
6. Find the percentage error in the area of an ellipse when an error of 1% each is made in measuring its semimajor and semiminor axes.
7. In a standing the cost of pile of bricks measurement as [2*15*1.2]m^3, the tape was stretched 1% beyond its standard length. If the count of bricks is 450 and cost of bricks is Rs.450 thousand, find the approximate error in the cost.
8. In estimating the cost of a pile of bricks measured as 6'*50'*4' ,the tape was stretched 1% beyond its standard length. If the count of bricks is 12 to 1 ft^3 and cost of bricks is Rs.100 per thousand, find the approximate error in the cost.
9. The focal length of a mirror is found from the formula $\frac{1}{v} - \frac{1}{u} = \frac{2}{f}$, find the percentage error in f if u and v are both in error by p% each.
10. Find the percentage error in the area of an ellipse when an error of 1% each is made in measuring its semi major and semi minor axes.

Progressive Education Society's

Modern College of Engineering

DEPARTMENT OF FIRST YEAR ENGINEERING

Curriculum

Name of the Subject: Engineering Physics

	Lecture	Tutorial	Practical
Weekly work Load (in Hrs.)	**4**	**0**	**2**

In Sem	Theory	Practical	Total Marks	Credit
30	**70**	**25**	**125**	**5**

1.1 Syllabus

Unit No.	Course Content	Hours
Unit-I	**Wave Optics** **Interference** Introduction to electromagnetic waves and electromagnetic spectrum Interference in thin film of uniform thickness (with derivation) Interference in thin film wedge shape (qualitative) Applications of interference: testing optical flatness, anti-reflection coating **Diffraction** Diffraction of light Diffraction at a single slit, conditions for principal maxima and minima, diffraction pattern Diffraction grating, conditions for principal maxima and minima starting from resultant amplitude equations, diffraction pattern Rayleigh's criterion for resolution, resolving power of telescope and grating **Polarization** Polarization of light, Malus law Double refraction, Huygen's theory of double refraction Applications of polarization: LCD	**08**
Unit-II	**Laser and Optic Fibre** **Laser** Basics of laser and its mechanism, characteristics of laser Semiconductor laser: Single Hetro-junction laser Gas laser: CO_2 laser Applications of lasers: Holography, IT, industrial, medical **Optic Fibre** Introduction, parameters: Acceptance Angle, Acceptance Cone, Numerical Aperture Types of optical fiber- step index and graded index Attenuation and reasons for losses in optic fibers (qualitative) Communication system: basic building blocks Advantages of optical fiber communication over conventional methods	**08**
Unit-III	**Quantum Mechanics** De-Broglie hypothesis Concept of phase velocity and group velocity (qualitative) Heisenberg Uncertainty Principle Wave-function and its physical significance Schrodinger's equations: time independent and time dependent Application of Schrodinger's time independent wave equation - Particle enclosed in infinitely deep potential well (Particle in Rigid Box) Particle in Finite potential well (Particle in Non Rigid box) (qualitative) Tunneling effect, Tunneling effect examples (principle only): Alpha Decay, Scanning Tunneling Microscope, Tunnel diode	**08**

	Introduction to quantum computing	
Unit-IV	**Semiconductor Physics** Free electron theory (Qualitative) Opening of band gap due to internal electron diffraction due to lattice Band theory of solids Effective mass of electron Density of states Fermi Dirac distribution function Conductivity of conductors and semiconductors Position of Fermi level in intrinsic and extrinsic semiconductors (with derivations based on carrier concentration) Working of PN junction on the basis of band diagram Expression for barrier potential (derivation) Ideal diode equation Applications of PN junction diode: Solar cell (basic principle with band diagram) IV Characteristics and Parameters, ways of improving efficiency of solar cell Hall effect: Derivation for Hall voltage, Hall coefficient, applications of Hall effect	**08**
Unit-V	**Magnetism and Superconductivity** **Magnetism** Origin of magnetism Classification of magnetism on the basis of permeability (qualitative) Applications of magnetic devices: transformer cores, magnetic storage, magneto-optical recording **Superconductivity** Introduction to superconductivity; Properties of superconductors: zero electrical resistance, critical magnetic field, persistent current, Meissner effect Type I and Type II superconductors Low and high temperature superconductors (introduction and qualitative) AC/DC Josephson effect; SQUID: basic construction and principle of working; Applications of SQUID Applications of superconductors	**08**
Unit-VI	**Non Destructive Testing and Nanotechnology** **Non Destructive Testing** Classification of Non-destructive testing methods Principles of physics in Non-destructive Testing Advantages of Non-destructive testing methods Acoustic Emission Testing Ultrasonic (thickness measurement, flaw detection) Radiography testing	**08**

	Nanotechnology Introduction to nanotechnology Quantum confinement and surface to volume ratio Properties of nanoparticles: optical, electrical, mechanical Applications of nanoparticles: Medical (targeted drug delivery), electronics, space and defense, automobile	

1.2 - Course Objectives

To Provide the students with foundation in physics in the area of optics, Laser, Semiconductor Physics, magnetism , superconductivity ,non destructive testing & Nano technology.

COURSE OUTCOMES

Engineering Physics Theory COs-

At the end of course students will able to:

CO-1- Explain concepts and applications of optics and Modern Physics.

CO-2 Apply the principles of physics for obtaining desired parameters.

CO-3 Apply Knowledge of physics Principles to the solution of Engineering Physics problems.

CO-4 Explain properties and applications of smart materials

Engineering Physics Practical COs-

Student will be able to

CO-1- Demonstrate optical experiments

CO-2- Determine the parameters related to semiconductor devices experimentally

CO-3 - Apply modern tools such as LASER and Ultrasonic distance metre for distance measurement.

CO-4 - Conclude the experiments of optics, modern physics and Laser.

1.3 - Text Books

According to SPPU Syllabus		
Sr. no.	**Book Name**	**Author Name & Publication**
1	Engineering Physics	Avadhanulu, Kshirsagar, S. Chand Publications
2	A textbook of optics	N Subrahmanyam and BriLal , S. Chand Publications
3	Engineering Physics	Gaur, Gupta, Dhanpat Rai and Sons Publications

Sem II

Sr. No.	Assessment Tool	Total in No (6 Units)	Marks scale down to
1	Assignment,	2	30
	Quiz	2	20
	Tutorial,	1	10
	Problem Set,	1	15
	PPT Presentation	1	10
2	Internal Tests		
	Pre In Sem (T1)	1	30
	Pre End Sem (T2)	1	60
Total			175

Assessment Tools

Assignment – A1 to A4 (Sem I)
A1 to A2 (Sem II)
Tutorials- T1 (Sem-II)
Problem set- P1(SEM-I)
P1 (Sem-II)
Quiz :- Q1 to Q2 (sem-I)
Q1 to Q2 (sem-II)
Class Tests – Pre In Sem (T1)
Pre End Sem (T2

1.6 Scheduled of Assessment Tools

Course Name – Engineering Physics (107002)

Teaching Scheme: Theory – 4Hrs/Week, Practical- 2 Hrs/Week
Marking Scheme: Theory Marks (100); ISE – 30 ESE – 70
Practical-25

Detail Schedule/Plan of conduction of assessment tool

Sem I

Sr. No.	CO No.	Assessment Tool	Marks	Schedule
1	1 to 4	Assignments	60	March to April 2021
2	1 to 4	Pre End Sem (T2)	60	29 April 2021
3	1 to 4	Quiz 1 and 2	20	31 March 2021
4	1 to 4	Problem Set	35	March to April 2021

Sem II

Sr. No.	CO No.	Assessment Tool	Marks	Schedule
1	1 to 4	Assignments, Tutorials	30+10=40	May to July 2021
2	1 to 4	Pre In Sem (T1)	30	15 June 2021
3	1 to 4	Pre End Sem (T2)	60	28 July 2021
4	1 to 4	Problem Set	15	May to July 2021
5	1 to 4	PPT presentation	10	6 July 2021
6	1 to 4	Quiz 1 and 2	20	13 June 2021

1.7 Practical Assessment

SEM I

Co Number	CO statement Student will be able to----	Practical	Total Marks
1	Demonstrate optical experiments	1. **Diffraction Grating** 2. **Malu's law**	**16**
2	Determine the parameters related to semiconductor devices experimentally	1. **Hall Effect** 2. **Solar Cell**	**16**
3	Apply modern tools such as LASER and Ultrasonic distance metre for distance measurement.	**1. Numerical Aperture of Optic Fibre**	**8**
4	Conclude the experiments of optics, modern physics and Laser	1. **Diffraction Grating** 2. **Malu's law** 3. **Hall Effect** 4. **Solar Cell** 5. **Numerical Aperture of Optic Fibre**	**10**

SEM II

Co Number	CO statement	Practical	Total Marks
1	Demonstrate optical experiments	1. **Newton's Rings** 2. **Diffraction Grating** 3. **Malu's law** 4. **Planck's Constant**	**32**
2	Determine the parameters related to semiconductor devices experimentally	1. **Energy Band gap** 2. **Solar Cell** 3. **HAll Effect**	**24**
3	Apply modern tools such as LASER and Ultrasonic distance metre for distance measurement.	**1. Ultrasonic Interferometer**	**8**
4	Conclude the experiments of optics, modern physics and Laser	1. **Newton's Rings** 2. **Diffraction Grating**	**16 + 10 = 26**

	.	**3. Malu's law** **4. Planck's Constant** **5. Energy Band gap** **6. Solar Cell** **7. HAll Effect** **8. Ultrasonic Interferometer** **9. Practical Test**	

1.8 Question Bank

Engineering Physics Question Bank Year 2020-21

Unit 1

Q1 Obtain the condition for constructive and destructive interference in thin uniform film in reflected light.

Q2 Obtain conditions for principal maxima, secondary maxima and minima in single slit diffraction using Amplitude expression and draw intensity distribution curve.

Q3 Explain Rayleigh criteria of Resolution and write expression for Resolving Power of Diffraction Grating and Telescope.

Q4 Explain Huygens' theory of double refraction. Write difference between positive and negative crystal.

Q5 Obtain conditions for maxima and minima in diffraction at a grating using Amplitude expression.

Q6 Explain non-reflecting film. Derive conditions for thickness of non-reflecting film. Explain and write its applications.

Q7 State and Explain Malu's Law.

Q8 What is polarised light and unpolarised light? Explain how the phenomenon of polarisation of light is used in LCD.

Q9 Explain interference in wedge shape film and write the conditions for constructive and destructive interference in reflected system.

Q10 Write a Short Note on Electromagnetic Spectrum .

Q11 Derive an expression for Resultant amplitude and resultant intensity between the diffracted waves in fraunhoffer diffraction due to a single slit.

Q12 Write the expression of path difference between the waves reflected in wedge shaped thin film. State the conditions for maxima and minima. Explain the application of wedge shaped thin film for testing of optical flatness.

Unit- 2

Q1 Explain principle, construction and working of CO2 Laser with the help of energy band diagram.

Q2 Draw basic block diagram of communication system and explain working of each block.

Q3 Explain principle, construction and working of Heterojunction Semiconductor Laser with the help of energy band diagram.

Q4 Explain any 3 Properties of laser.

Q5 What is holography? Explain process of Hologram Recording and Reconstruction.

Q6 Write 4 advantages of optical fibre communication system and explain any one.

Q7 Define and Explain: Spontaneous Emission, Stimulated emission, Metastable state, Population inversion, Pumping, Active Medium.

Q8 State and Explain Application of laser.

Q9 Describe different factors responsible for loss of signal propagating through optical fibre.

Q10 Explain the mode of propagation for step index and graded index fibre along with mode of fibres.

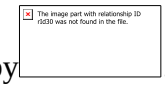
Q11 Define and explain i) total internal reflection ii) Numerical aperture iii) acceptance angle iv) critical angle

Q12 Differentiate between step index and graded index fibre.

Unit- 3

Q1 State the de Broglie hypothesis and derive the equation of de Broglie wavelength in terms of energy.

Q2 Explain how the concept of a de Broglie group wave is associated with the Heisenberg's uncertainty principle.

Q3 Show that the wavelength associated with an electron, accelerated by a potential difference of V volts, is given by 

.

Q4 Show that the phase velocity of a matter wave is c^2/v, where c is the speed of light and v is the velocity of the particle.

Q5 Starting from the uncertainty principle for the position-momentum pair, derive the uncertainty principle for the Energy-time pair.

Q6 What is the de Broglie wavelength of an electron at rest?

Q7 Derive the Schrodinger's time independent equation by setting up a wave equation and using the de Broglie wavelength.

Q8 Derive the Schrodinger's time dependent equation starting from the Schrodinger's time independent equation.

Q9 Derive an expression for the energy levels and the wave functions of a particle enclosed in an infinite potential well.

Q10 Derive an expression for the energy levels and the wave functions of a particle enclosed in an finite potential well.

Q11 What is the physical significance of ψ and ϕ. What is normalization of a wave function?

Q12 What is tunneling effect?

Unit- 4

Q1 What is Fermi energy ? What is Fermi function? Show the location of Fermi energy levels in intrinsic and extrinsic semiconductors.

Q2 Derive an expression for conductivity in a metal.

Q3 Give the energy band picture of P-N junction diodes and explain the effect of biasing on the band picture.

Q4 What is Fermi energy level.Write probability distribution function. Draw figure for probability distribution functionVs E at T=0K, T1 and T2 K.

Q5 Discuss the working of NPN transistors. Explain with respect to the energy band diagram.

Q6 What is Fermi function? Show that the Fermi level lies at the centre of the energy gap in an intrinsic

Q7 Explain Hall Effect and Hall coefficient.

Q8 Write a note on solar cell.

Q9 Derive conditions for conductivity for an intrinsic and extrinsic semiconductor.

Q10 Explain Band theory of solids.

Unit- 5

Q1 Define Magnetic susceptibility and Magnetic flux

Q2 Explain how the information is recorded and retrieved in magneto optical recording devices.

Q3 Explain in brief what is ferromagnetic materials and their characteristics?

Q4 Explain how the information is recorded and retrieved in magnetic storage devices.

Q5 Define magnetic dipole, magnetic dipole moment and magnetic field strength.

Q6 Explain the type of magnetic material on the basis of magnetic susceptibility and magnetic permeability.

Q7 Define critical magnetic field and persistent current

Q8 Differentiate between type I & type II superconductors

Q9 What are SQUIDs? Explain their applications in brief.

Q10 Explain the Large scale applications of superconductors.

Unit- 6

Q1 What is NDT? State advantages of NDT as compared with destructive testing

Q2 Discus in brief applications of ultrasonic in flaw detection

Q3 Discus in brief radiography testing. Also explain X-Ray radiography.

Q4 Explain Gamma ray radiography testing and fluoroscopy testing of NDT.

Q5 Explain Acoustic Emission Testing and its applications.

Q6 Explain electrical properties of nanoparticles.

Q7 Explain quqntum confinement and surface area to volume ratio of Nanoparticles.

Q8 Explain electrical properties of nanoparticles.

Q9 What are the applications of nanomaterial? Explain any one application in brief.

Q10 Explain Optical properties of nanomaterial.

1.2 Reference Books

Other References

1. Fundamentals of Physics, Resnick and Halliday (John Wiley and Sons)
2. Optics, Jenkins and White (Tata Mcgraw Hill)
3. Principles of Physics, Serway and Jewett (Saunders college publishing)
4. Introduction to Solid State Physics, C. Kittel (Wiley and Sons)
5. Principles of Solid State Physics, H. V. Keer, New Age International
6. Laser and Non-Linear Optics, B. B. Laud (Oscar publication)
7. Nanotechnology: Principles and Practices, Dr. S. K. Kulkarni (Capital Publishing Company

1.6 Teaching Plan

Sr No.	Unit	Broad topic to be covered	Books Referred	Total Lectures planned
1	I	**Wave Optics** **Interference** Introduction to electromagnetic waves and electromagnetic spectrum Interference in thin film of uniform thickness (with derivation) Interference in thin film wedge shape (qualitative) Applications of interference: testing optical flatness, anti-reflection coating **Diffraction** Diffraction of light Diffraction at a single slit, conditions for principal maxima and minima, diffraction pattern Diffraction grating, conditions for principal maxima and minima starting from resultant amplitude equations, diffraction pattern Rayleigh's criterion for resolution, resolving power of telescope and grating **Polarization** Polarization of light, Malus law Double refraction, Huygen's theory of double refraction Applications of polarization: LCD	T1,T2, R1,R2	8
2	II	**Laser and Optic Fibre** **Laser** Basics of laser and its mechanism, characteristics of laser Semiconductor laser: Single Hetro-junction laser Gas laser: CO_2 laser Applications of lasers: Holography, IT, industrial, medical **Optic Fibre** Introduction, parameters: Acceptance Angle, Acceptance Cone, Numerical Aperture Types of optical fiber- step index and graded index Attenuation and reasons for losses in optic fibers (qualitative) Communication system: basic building blocks Advantages of optical fiber communication over conventional methods	T1,T2, R1,R2,R6	8

3	III	**Quantum Mechanics** De-Broglie hypothesis Concept of phase velocity and group velocity (qualitative) Heisenberg Uncertainty Principle Wave-function and its physical significance Schrodinger's equations: time independent and time dependent Application of Schrodinger's time independent wave equation - Particle enclosed in infinitely deep potential well (Particle in Rigid Box) Particle in Finite potential well (Particle in Non Rigid box) (qualitative) Tunneling effect, Tunneling effect examples (principle only): Alpha Decay, Scanning Tunneling Microscope, Tunnel diode Introduction to quantum computing	T1,T3,R3 .	8
4	IV	**Semiconductor Physics** Free electron theory (Qualitative) Opening of band gap due to internal electron diffraction due to lattice Band theory of solids Effective mass of electron Density of states Fermi Dirac distribution function Conductivity of conductors and semiconductors Position of Fermi level in intrinsic and extrinsic semiconductors (with derivations based on carrier concentration) Working of PN junction on the basis of band diagram Expression for barrier potential (derivation) Ideal diode equation Applications of PN junction diode: Solar cell (basic principle with band diagram) IV Characteristics and Parameters, ways of improving efficiency of solar cell Hall effect: Derivation for Hall voltage, Hall coefficient, applications of Hall effect	T1,T3,R4 ,R5	8
5	V	**Magnetism and Superconductivity** **Magnetism** Origin of magnetism Classification of magnetism on the basis of permeability (qualitative) Applications of magnetic devices: transformer cores, magnetic storage, magneto-optical recording **Superconductivity** Introduction to superconductivity; Properties of superconductors: zero electrical resistance, critical magnetic field, persistent current, Meissner effect Type I and Type II superconductors	T1,T3 ,R4,R5	8

		Low and high temperature superconductors (introduction and qualitative) AC/DC Josephson effect; SQUID: basic construction and principle of working; Applications of SQUID Applications of superconductors		

6	VI	**Non Destructive Testing and Nanotechnology** **Non Destructive Testing** Classification of Non-destructive testing methods Principles of physics in Non-destructive Testing Advantages of Non-destructive testing methods Acoustic Emission Testing Ultrasonic (thickness measurement, flaw detection) Radiography testing **Nanotechnology** Introduction to nanotechnology Quantum confinement and surface to volume ratio Properties of nanoparticles: optical, electrical, mechanical Applications of nanoparticles: Medical (targeted drug delivery), electronics, space and defense, automobile	T1,T3,R7	8

1.7 Assessment Tools Details

Sem I

Sr. No.	Assessment Tool	Total in No (4 Units)	Marks scale down to
1	Assignment, Quiz, Problem Set	4 2 2	15 x 4 = 60 10 x 2 = 20 15 + 20 = 35
2	Internal Tests Pre End Sem (T2)	1	60
Total			175

Progressive Education Society's

Modern College of Engineering

DEPARTMENT OF FIRST YEAR ENGINEERING

SYSTEMS IN MECHANICAL ENGINEERING Sem-I

Course Title: Systems in Mechanical Engineering		**Course Number: 2019 COURSE**	**CourseCode:102003**
Year:FE 2019-20		**Semester: I**	
Designation of Course		**Professional Core**	
TeachingScheme:3 Hrs/Week		**Practical:2 Hrs/Week**	
Course Assessment Methods	**External**	**In-Sem Examination(30 marks)**	**End Semester Examination(70 Marks)**
		PR(25 Marks)	
	Internal	**Class Tests**	**Assignments**
Prerequisites	**Basic terms like heat, work and energy etc**		
Course Objectives			
1	**To identify the sources of energy and their conversions**		
2	**To explain the basic concept of engineering thermodynamics and its application**		
3	**To understanding the specifications of vehicles**		

4	**To get acquainted with vehicle systems**
5	**To introduce manufacturing processes applying proper method to produce** **Components**
6	**To be able to select and compare domestic appliances**
Course Outcomes	
CO1	**Describe and compare the conversion of energy from renewable and non-** **Renewable energy sources**
CO2	**Explain basic laws of thermodynamics ,heat transfer and their applications**
CO3	**List down the types of road vehicles and their** **specifications**
CO4	**Illustrate various basic parts and transmission system of a road** **vehicle**
CO5	**Discuss several manufacturing processes and identify the suitable** **process**
CO6	**Explain various types of mechanism and its application**

Course Contents	
Unit-I	
Introduction Of energy sources & its conversion(6Hrs.)	**Energy sources: Thermal energy, Hydropower energy, Nuclear energy, Solar energy,Geothermalenergy,Wind Energy, Hydrogenenergy,BiomassenergyandTidalenergy.GradesofEnergy.(*Numerical On Efficiency Calculation of thermal power plant*)** **Energy conversion devices: Introduction of pump,compressor, turbines,wind mills etc(*Simple numerical on power and efficiency calculations)***

Assignment:	Energy Sources(MinimumoneassignmentonConventionalandoneonNon-conventionalsources)
Experiment:	Demonstration Of Energy Conversion Devices
Unit-II	
Introductionto ThermalEngineering(06Hrs)	Laws of thermodynamics, heat engine, heat pump, refrigerator *(simplenumerical)* Modes of heat transfer: conduction, convection and radiation, Fourier's law,Newton'slaw ofcooling,StefanBoltzmann'slaw.*(Simplenumerical)* TwostrokeandFourstrokeengines(Petrol,DieselandCNGengines).Steam generators
Assignment:	CourseTeachershavetodecideassignmentifnecessaryasper SPPUsyllabus

Experiment:	-
Unit-III	
Vehicles andtheirSpecifications(04Hrs)	Classification Of Automobile.Vehicle Specifications Of Two/three wheeler,light motor vehicles,trucks,buses and multi-axle vehicles.Engine Components(Introduction). Study of engine specifications, comparison of specifications of vehicles.Introduction ElectricandHybridVehicles.Costanalysisofth e Vehicle.
Assignment	Vehicle Specifications And Systems In Passenger car
Experiment:	-
Unit-IV	
Vehiclesystems (08Hrs)	Introduction of chassis layouts, steering system, suspension system, braking system,cooling system and fuel injection system and fuel supply system. Study of Electricand Hybrid Vehicle systems. Study of power transmission system, clutch, gear box(Simple Numerical), propeller shaft, universal joint, differential gearbox and axles.Vehicleactiveandpassivesafetyarrangements:seat,seatbelts, airbagsandantilock brakesystem.
Assignment:	Electric vehiclespecificationsanditssystems
Experiment:	1. Demonstrationofpowertrainsystemin thevehicle 2. Demonstration of vehicle systems (automobile chassis, steering system, suspensionsystem,brakingsystem-AnyTwo)

Unit-V	
Introductionto Manufacturing (06Hrs)	Conventional Manufacturing Processes: Casting, Forging, Metal forming (Drawing,Extrusion, etc.), Sheet metal working, Metal joining, etc. Metal cutting processes andmachiningoperations-Turning,MillingandDrilling,etc. Micromachining. Additive manufacturing and 3D Printing. Reconfigurablemanufacturing system and IOT, Basic CNC programming: Concept of ComputerNumericalControlledmachines
Assignment:	CourseTeachershavetodecideassignmentifnecessaryasper SPPUsyllabus

Experiment:	1.Demonstration of additive manufacturing / rapid prototyping techniques2.DemonstrationofCNC
Unit-VI	
EngineeringMechanismsandtheirapplicationin DomesticAppliances(6Hrs.)	**Introduction to Basic mechanisms and equipment**: Pumps, blowers,compressors, springs, gears, Belt-Pulley, Chain-Sprocket, valves, levers, etc.Introduction To Terms:Specifications,Input,output,efficiency,etc. **Applications of**: Compressors - Refrigerator, Water cooler, Split AC unit;Pumps - Water pump for overhead tanks, Water filter/Purifier units; Blower - Vacuum cleaner, Kitchen Chimney; Motor - Fans, Exhaust fans, Washing Machines; Springs - Door closure, door locks, etc.; Gears - Wall clocks,watches, Printers, etc.; Application of Belt-Pulley/Chain-Sprocket -Photocopier, bicycle, etc.; Valves - Water tap, etc.; Application of levers - Doorlatch, Brakepedals,etc.;Electric/Solar energy-

	Geyser,Waterheater, Electric iron, etc.(simple numerical one efficiency calculation)
Assignment:	Domestic appliances viz.refrigerator,air-conditioner,washing machine,cold storage
Experiment:	-

TextBooks	**Author**	**Title ofBook**	**Publication**
T1	Nag,P.K.	EngineeringThermodynamics	TataMcGraw
T2	Moran, M.J., Shapiro, H. N., Boettner, D. D.,andBailey,M	Fundamentals ofEngineeringThermodynamics	Wiley
T3	Chaudhariand Hajra	Elements of Workshop TechnVolume IandII	Prentiers Publishers,Mumbai

T4	Rajput,R.K	Basic MechanicalEngineering	LaxmiPublicationsPvt.Ltd.
Reference Books			
R1	Khan, B.H	Non-Conventional EnergySources	TataMcGraw-Hill
R2	Groover,MikellP.	Fundamentals of ModernManufacturing:Materials,Processes,and Systems	PrenticeHall,USA
R3	Norton, RobertL.	Kinematics and DynamicsofMachinery	TataMcGrawHill
R4	**Ganeshan,V.**	**Internal CombustionEngines**	**McGrawHill**
R5	**Anderson, CurtisDarrelandAnderson,Judy**	**Electric and HybridCars:AHistory**	**McFarland**
R6	**Khumi, R.S.,andGupta,J.K.**	**A Textbook of ThermalEngineering**	**S. Chand&Sons**

Self-LearningFacilities,WebResources,Researchpapersfor reference	**Video Lecture on Thermodynamics, Heat transfer and ManufacturingProcessesfromIIT**

Contents beyondSyllabus	**PresentationofDifferent typesofboiler working,manufacturingprocesses**
AdditionalExperiments	-
BridgingCourses	-
Presentations	• **Unitwisepresentationofsubtopicstobedisplayed onprojector** • **VideosonworkingofPump, ICengine, Boiler andManufacturingProcesses** • **ImagesofsomeBasicmechanismsandequipment**

SME QUESTION BANK

Unit 1 Question Bank

Q1. What is wind energy? How is electricity produced from wind energy? Explain with neat sketch.
Q2. What is the basic principle of tidal energy? Describe tidal power plant with schematic diagram.
Q3. Describe hydroelectric power plant with schematic layout.

Q4. Explain working of centrifugal pump with neat diagram.

Q5. Explain working of single stage single acting reciprocating compressor with neat diagram

Q6. A steam power plant has coal consumption of 16200 Kg/hr with calorific value of coal as 17793.9 kJ/kg. If the speed of steam turbine is 1000 rpm and generated torque is 477464.8293Nm.
Find: (i) Input power (ii) Output power (iii) Efficiency.

Unit 2 Question Bank

Q1. Explain second law of thermodynamics with sketch.
Q2. Compare two stroke and four stroke SI engine.
Q3. Define heat pump and COP of heat pump.

Q4. A heat pump is used to maintain house at 24 c. House is losing heat at rate of 1800 KJ/min to Surrounding. Heat pump is driven by electric motor of power rating 12kW.Find amount of heat absorbed from surrounding and COP.

Q5 A fish freezing plant is to be maintained at -10c, if power required to drive plant is 30kW and COP=3. Find i)heat absorbed from freezing plant ii)Heat rejected to surrounding

Q6. A heat pump is used to maintain the house at 25 c, the house is losing heat at rate of 60000 KJ/hr to surrounding, while heat generated in house by various appliances is 4000KJ/hr. If COP is 1.5 find power required.

Unit 3 Question Bank

Q1. Explain parts of IC engine with their functions.
Q2. Write specifications of 4 wheeler passenger vehicle.
Q3. Write specifications of any 2 wheeler.

Q4. Explain in detail how costing of a vehicle is carried out?

Q5 Explain with neat sketch Front engine front wheel drive and Front engine rear wheel drive.

Unit 4 Question Bank

Q1. Draw neat labeled diagram of layout of an automobile chasis.

Q2. Explain fuel supply system for diesel system.

Q3. Write short note on electric vehicle.

Q4. Write short note on active safety system.

Q5. Write short note on passive safety system.

Q6. Write short note on hybrid vehicle.

Q7.Explain MPFI system.

Q8. Explain working of disc brake with neat sketch.

Unit 5 Question Bank

Q1. What is sand casting? Explain its advantages, disadvantages and applications.
Q2. Explain working principle and basic elements of drilling machine.
Q3. Explain working principle and basic elements of lathe machine..

Q4. Explain taper turning, parting and knurling operations performed on lathe machine.

Q5. Draw self explanatory sketches of any four sheet metal cutting process.

Q6. What is forging? Explain its advantages, disadvantages and applications.

Q7. Write short note on surface grinding.

Unit 6 Question Bank

Q1. Explain the function of compressor in refrigeration device.
Q2 What are refrigeration, refrigerator, refrigerant and Ton of Refrigeration?

Q3. Explain the vapour compression refrigeration cycle with neat sketch.

Q4 What are the applications of refrigerator?

Q5. What is working principle of washing machine? Explain how it works.

Q6. Give a brief description of vacuum cleaner.

Q7. Explain working of exhaust fan.

Q8. Write a short note on door latch.

Q9. Explain working of photo copier.

Q6. What is forging? Explain its advantages, disadvantages and applications.

Q7. Write short note on surface grinding.

Curriculum

Name of the Subject: Basic Electrical Engineering

Faculty

	Lecture	Tutorial	Practical
Weekly work Load (in Hrs.)	**3**	**0**	**2**

In Sem	Theory	Practical	Total Marks	Credit
30	**70**	**25**	**125**	**4**

Progressive Education Society's
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DEPARTMENT OF FIRST YEAR ENGINEERING

BASIC ELECTRICAL ENGINEERING Sem-I/II

Course Name : Basic Electrical Engineering Course Number : 103004			
Teaching Scheme **Theory : 3 Hrs. / week** **Practical : 2 Hrs. / week**	**Credits Th : 03** **PR : 01**	**Examination Scheme [Marks] In Sem: 30 Marks** **End Sem : 70 Marks** **Practical : 25 Marks**	
Designation of the Course : Professional-Core		**Course Number:**	**C104**
Prerequisites :			
1. Basic knowledge of electrical parameters.			
2. Basic knowledge of electrical sources.			
3. Ohms law & Faradays law			
4. Engineering physics, electron theory, electricity, potential and kinetic energy			
Course Objectives :			
1.	To introduce fundamental concepts, various laws-principles and theorems associated with electrical systems.		
2.	To impart basic knowledge of all electrical quantities such as current, voltage, power, energy, frequency along with different types of fields.		

3.	To provide knowledge about fundamental parameters such as resistance, inductance and capacitance and magnetic circuits, AC and DC circuits.
4.	To provide knowledge of the concepts of transformer, different energy conversions techniques.

Course Outcomes :
At the end of the course, a graduate will be able to –

CO1.	Differentiate between electrical and magnetic circuits and derive mathematical relation for self and mutual inductance along with coupling effect.
CO2.	Calculate series, parallel and composite capacitor as well as characteristics parameters of alternating quantity and phasor arithmetic.
CO3.	Derive expression for impedance, current, power in series and parallel RLC circuit with AC supply along with phasor diagram.
CO4.	Relate phase and line electrical quantities in polyphase networks, demonstrate the operation of single phase transformer and calculate efficiency and regulation at different loading conditions.
CO5.	Apply and analyze the resistive circuits using star-delta conversion, KVL, KCL and different network theorems under DC supply.
CO6.	Evaluate work, power, energy relations and suggest various batteries for different applications, concept of charging and discharging and depth of charge.

Course Contents :

Unit 1 :	**Electromagnetism:**	**[6 Hrs]**

Review: resistance, emf, current, potential, potential difference and Ohm's law.

Electromagnetism: Magnetic effect of an electric current, cross and dot conventions, right hand thumb rule, nature of magnetic field of long straight conductor, solenoid and toroid. Concept of mmf, flux, flux density, reluctance, permeability and field strength, their units and relationships. Simple series magnetic circuit, Introduction to parallel magnetic circuit(Only theoretical treatment), comparison of electric and magnetic circuit, force on current carrying conductor placed in magnetic field, Fleming's left hand rule. Faradays laws of electromagnetic induction, Fleming's right hand rule, statically and dynamically induced e.m.f., self and mutual inductance, coefficient of couplings.
Energy stored in magnetic field.

Unit 2 :	**Electrostatics and AC Fundamentals**	**[6 Hrs]**

A) Electrostatics: Electrostatic field, electric flux density, electric field strength, absolute permittivity, relative permittivity and capacitance. Capacitor, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors (no derivation) and time constant. (2Hrs)

B) AC Fundamentals: Sinusoidal voltages and currents, their mathematical and graphical representation, Concept of cycle, Period, frequency, instantaneous, peak(maximum), average and
r.m.s. values, peak factor and form factor. Phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasor.
(4Hrs)

Practical:-
To calculate and measure of charging and discharging of capacitor and observe the response on storage oscilloscope.

Unit 3 :	**Single Phase AC Circuits**	**[6 Hrs]**

Study of AC circuits consisting of pure resistance, pure inductance, pure capacitance, series R-L, R- C and R-L-C circuits, phasor diagrams, voltage, current and power waveforms, resonance in series RLC circuits, concept of impedance, concept of active, reactive, apparent, complex power and power factor, Parallel AC circuits (No numericals), concept of admittance

Practical:-

- To measure steady state response of series RL and RC circuits on AC supply and observations of voltage and current waveforms on storage oscilloscope.
- To derive resonance frequency and analyze resonance in series RLC circuit.

Unit 4 :	**Polyphase A.C. Circuits and Single phase Transformers**	**[6 Hrs]**

A) Polyphase A.C. Circuits: Concept of three-phase supply and phase sequence. Balanced and unbalanced load, Voltages, currents and power relations in three phase balanced star-connected loads and delta-connected loads along with phasor diagrams. (3Hrs)
B) Single phase transformers: principle of working, construction and types, emf equation, voltage and current ratios. Losses, definition of regulation and efficiency, determination of these by direct loading method. Descriptive treatment of autotransformers. (3Hrs)

Practical:-

- To verify the relation between phase and line quantities in three phase balanced star and delta connections of load.

- To determine efficiency and regulation of transformer by direct loading test of a single phase transformer

Unit 5 :	**DC circuits**	**[6 Hrs]**

Classification of electrical networks, Energy sources – ideal and practical voltage and current sources, Simplifications of networks using series and parallel combinations and star-delta conversions, Kirchhoff's laws and their applications for network solutions using loop analysis, Superposition theorem, Thevenin's theorem.

Practical:-

- To verify KVL and Superposition theorem.
- To verify Thevenin's theorem in a DC network

Unit 6 :	**Work, Power, Energy and Batteries**	**[6 Hrs]**

A) Work, Power, Energy: Effect of temperature on resistance, resistance temperature coefficient, insulation resistance, conversion of energy from one form to another in electrical, mechanical and thermal systems. (4Hrs)

B) Batteries :Different types of batteries (Lead Acid and Lithium Ion), construction, working principle, applications, ratings, charging and discharging, concept of depth of charging, maintenance of batteries, series - parallel connection of batteries. (2Hrs)

Study Experiment:

1. To study safety precautions while working on electrical systems, handling of various equipment's such as multimeter, ammeters, voltmeters, wattmeter's, real life resistors, inductors and capacitors.
2. To measure insulation resistance of electrical equipment's/cable using Megger
3. To demonstrate different types of electrical protection equipments such as fuses, MCB, MCCB, and ELCB.
4. To measure earth resistance at substation earthing using fall of potential method with IS 3043 standard.
5. To study LT and HT electricity bills.

(Any two experiment from Sr. No. 2 to 5)

Text Books :

[T1]	V.D. Toro, Principles of Electrical Engineering, Prentice Hall India, 1989
[T2]	D. P. Kothari, I.J. Nagrath, Theory and Problems of Basic Electrical Engineering, PHI Publication
[T3]	V.K. Mehta, Rohit Mehta Basic Electrical Engineering, S Chand Publications

[T4]	B.L. Theraja, A text book on electrical technology Vol-I, S Chand Publications
Reference Books :	
[R1]	H Cotton, Electrical technology, CBS Publications
[R2]	L. S. Bobrow, ―Fundamentals of Electrical Engineering‖, Oxford University Press, 2011.
[R3]	E. Hughes, ―Electrical and Electronics Technology‖, Pearson, 2010.
[R4]	D. C. Kulshreshtha, ―Basic Electrical Engineering‖, McGraw Hill, 2009.

Guidelines for Student's Lab Journal :
The Student's Lab Journal should contain following related to every experiment – • Theory related to the experiment. • Apparatus with their detailed specifications. • Connection diagram /circuit diagram. • Observation table • Sample calculations for one/two reading. • Result table. • Graph and Conclusions. • Few short questions related to the experiment.
Assignment Topics :
Assignment should include questions on theory & numerical.

Question Bank

Unit No-I

Electromagnetism

1. Define EMF and state its unit.
2. Define resistance and state its unit.
3. State factors affecting resistance.
4. State and explain Ohm's Law.
5. What is magnet and magnetic field? State the laws of magnetism.
6. Define (State units)
   1) Magnetic Flux

2) Magnetic flux Density

3) Magnetic field strength

7. What is electromagnet?

8. What is the magnetic effect of electric current on

a) Long straight Conductor

b) Solenoid

c) Toroid

9. Explain Right Hand Thumb Rule, Corkscrew Rule, Dot and Cross Conventions.

10. Explain the nature of magnetic field of long straight conductor.

11. Define and explain (derivation if required) with units

1) MMF

2) Permeance

3) Permeability (Absolute and relative)

4) Reluctance (mention both formulae)

12. Derive relation between mmf, flux and reluctance.

13. Write a note on series magnetic circuit with air gap (derivation).

14. Why air gap is kept minimum in toroid?

15. State Kirchhoff's laws for magnetic circuit.

16. Explain magnetic leakage and fringing.

17. Compare magnetic and electric circuits.

18. Define leakage coefficient and state its importance.

19. State and explain Fleming's left hand rule.

20. Obtain the expression for force experienced by the current carrying conductor in the magnetic field.

21. What is electromagnetic induction?

22. State and explain Faraday's Law of EMI.

23. What is dynamically induce emf? Derive expression for its magnitude.

24. State Fleming's Right Hand Rule.

25. State and Explain Lenz's Law.

26. What is statically induced emf?

27. Compare statically and dynamically induced EMF.

28. Explain the Phenomenon of Self-induced EMF.(Definition, Derivation, Coefficient & factors affecting on it)

29. Explain the Phenomenon of Mutually-induced EMF.(Definition, Derivation, Coefficient & factors affecting on it)

30. Define coefficient of Coupling. State relation Between Self and mutually induced EMF.

31. Derive expression for the energy stored in magnetic field.

32. Obtain the expression for the energy stored in magnetic field per unit volume in an inductor.

UNIT II QUESTION BANK

ELECTROSTATICS AND AC FUNDAMENTALS

1. State and explain the laws of electrostatics.
2. Define electrostatic field.
3. What are electric lines of force? State their properties.
4. Define
    i. Electric flux
    ii. Electric flux density
    iii. Electric field strength
5. What is permittivity? State its classification with their units.
6. What is a capacitor? Define capacitance and state its unit.
7. Explain the action of the capacitor.
8. State the relation between charge, capacitance and applied voltage.
9. Define dielectric strength. What do you understand about dielectric strength and dielectric breakdown?
10. Derive expression for equivalent capacitance when capacitors are connected in:
    i. Series
    ii. Parallel
11. Derive expression for energy stored in capacitor.
12. Explain charging of a capacitor through a resistance with graphs.
13. Explain discharging of a capacitor through a resistance with graphs.

14. What is ac? How it differs from ac
15. State advantages of ac over dc.
16. Sketch a sinusoidal waveform and define following terms:
    i. Instantaneous value
    ii. Waveform
    iii. Cycle
    iv. Time period
    v. Frequency
    vi. Amplitude (peak value)
17. State the equation for alternating quantity and its various forms.
18. Define r.m.s. value of alternating quantity and derive relation between rms value and maximum value of an alternating quantity.
19. Define average value of alternating quantity and derive relation between average value and maximum value of an alternating quantity.
20. Define form factor and peak factor.
21. What is phasor? How does a rotating phasor represent an alternating quantity?
22. Explain the concept of phase and phasor in alternating quantities.
23. What is phasor diagram?
24. Explain the concept of lagging, leading and in phase phasors. Draw the respective waveforms and phasor diagrams.
25. Explain polar representation of an alternating quantity.
26. Explain polar representation of an alternating quantity.
27. Explain:
    i. Polar to rectangular conversion
    ii. Rectangular to polar conversion

UNIT III QUESTION BANK

SINGLE PHASE AC CIRCUITS

1. Prove that the voltage and current in a purely resistive circuit are in phase.
2. Derive expression for instantaneous power in a pure resistor energized by sinusoidal voltage.
3. Prove that in a purely inductive circuit current lags the voltage by 90°.
4. Derive expressions for current and power for a purely inductive circuit when voltage applied

is v(t) = Vm sin (ωt). Draw corresponding waveforms.

5. Explain the concept of inductive reactance. How does it depends on frequency?
6. Show that the average power consumed by an inductor is zero.
7. Prove that in a purely capacitive circuit current leads the voltage by 90°.
8. Derive expressions for current and power for a purely capacitive circuit when voltage applied

is v(t) = Vm sin (ωt). Draw corresponding waveforms.

9. Explain the concept of capacitive reactance. How does it depends on frequency?
10. Show that the average power consumed by a capacitor is zero.
11. Define and explain concept of impedance.
12. Derive and show the waveformsfor voltage, current and power R-L series circuit when voltage

applied is v(t) = Vm sin (ωt). Also draw:

i. Phasor diagram.

ii. Impedance triangle

iii. Power triangle

13. Define active power, reactive power and reactive power in power triangle of Q. 12
14. Define power factor.
15. Obtain the expression for power, when voltage v = Vm sin (ωt) is applied across a R-L series

circuit. Draw circuit and phasor diagram.

16. For a single phase a.c. circuit, applied voltage is v = Vm sin (ωt) and current drawn is I = Im sin

(ωt-φ). Derive expression for average power. Draw waveforms of voltage, current and power over one cycle of voltage.

17. Derive and show the waveforms for voltage, current and power R-C series circuit when voltage

applied is v(t) = Vm sin (ωt). Also draw:

i. Phasor diagram.

ii. Impedance triangle

iii. Power triangle

18. Sketch and explain phasor diagram of R-L-C circuit for (i) XL > XC (ii) XC > XL (iii) XL = XC.

19. What is admittance? Which are two components? State their units. How the admittance is expressed in polar and rectangular forms. (Explain admittance triangle).

20. What is resonance in series circuit? State characteristics of series resonance.

21. Derive the expression for the resonant frequency of a series RLC circuit

UNIT IV QUESTION BANK

POLYPHASE AC CIRCUITS AND SINGLE PHASE TRANSFORMERS

1. What is three phase system? State advantages of three phase system over single phase system.

2. Explain generation of three phase voltage in alternator.

3. Prove that phasor sum of instantaneous three phase voltages in a symmetrical system is zero.

4. Define phase sequence of 3 phase alternating supply. State its significance.

5. Define symmetrical three phase system.

6. Explain :

i. Star connection of a three phase system

ii. Delta connection of a three phase system

7. Explain the concept of phase voltages and phase currents.

8. Define balanced and unbalanced load.

9. Derive the relation between line and phase values of currents and voltages for balanced three

phase star connected load connected across three phase a.c. supply. Derive the expression

for the power consumed by the load.

10. Draw complete phasor diagram for three phase star connected inductive load connected

across a three phase a.c. supply.

11. Draw connection diagram for three phase star connected load connected across three phase

AC supply.

12. Derive the relation between line and phase values of currents and voltages for balanced three

phase delta connected load connected across three phase a.c. supply. Derive the expression

for the power consumed by the load.

13. Draw complete phasor diagram for three phase delta connected inductive load connected

across a three phase a.c. supply.

14. Draw connection diagram for three phase delta connected load connected across three phase

AC supply.

15. Explain power triangle for three phase load. State equations of real, apparent power and

reactive power for three phase balanced load.

16. What is a transformer? What are its functions? Mention applications in AC transmission.

17. Explain the working principle of the transformer.

18. With neat sketches, explain various types of laminations used for construction of core of a

single phase transformer.

19. What are types of transformers? Show the comparison.

20. Derive e.m.f. equation of single phase transformer.

21. What is an ideal transformer?

22. Explain voltage and current ratios of the transformer.

23. Why ratings of transformers specified in volt-amperes?

24. What is the regulation of transformers? State expression to calculate regulation. State its

importance.

25. Explain various losses in the transformer. In which part do these losses occur? How to minimize

them?

26. Define efficiency of the transformer. How to obtain efficiency on different loads?

27. Derive condition for maximum efficiency of transformer.

28. With the help of a neat diagram, describe the direct loading test of a single phase transformer. Explain how efficiency and regulation are calculated from test results.

29. Write a note on the auto-transformer. state its advantages, disadvantages and applications

UNIT V QUESTION BANK

D.C. CIRCUITS

1. Classify electrical networks. Explain each type in brief.
2. Explain ideal and practical voltage sources.
3. Explain ideal and practical current sources.
4. Derive expression for equivalent of 'n' resistances connected in (i) series and (ii) parallel.
5. Compare series and parallel circuits.
6. Explain current division in parallel connection of resistors.
7. State and explain Kirchhoff's laws with suitable sign conventions.
8. Define star and delta connection of resistances.
9. Derive equations to convert delta connected resistance to equivalent star connection of resistances.
10. Derive equations to convert star connected resistance to equivalent delta connection of resistances.
11. Explain source transformation.
12. State and explain Superposition theorem (with steps).
13. State and explain Thevenin's theorem (steps).

UNIT VI QUESTION BANK

WORK, POWER AND ENERGY

1. Define resistance and state its unit.
2. Explain the effect of temperature on resistance of various materials with the help of graph.
3. Define temperature coefficient of resistance and state its unit.
4. Prove that .
5. Define insulation resistance. Derive expression for insulation resistance for a cable. Discuss the effect of temperature and moisture on it.
6. How the cells are classified? Compare primary and secondary cells.
7. Explain construction of a lead acid battery.
8. Explain charging of a lead acid battery. What are the changes taking place during charging?
9. Describe maintenance procedure of a lead acid battery.
10. State functions of a separator in a lead acid battery.
11. Write down chemical reactions during first charging and recharging of a lead acid battery.
12. Write indications which confirm that a lead acid battery is fully charged.
13. State applications of a lead acid battery.
14. Explain construction and working of a lithium ion battery with reactions.
15. State advantages, disadvantages and applications of a lithium ion battery.
16. How is battery capacity measured?
17. Explain battery charging in brief and state indications of a fully charged battery.

Workshop Sem-I

Course Title: Workshop Practice	**Course Number: 2019 COURSE**	**CourseCode: 111006**

Year:FE 2019-20		**Semester: I**	
Designation of Course		**Professional Core**	
Teaching Scheme: Nil		**Practical:2Hrs/Week**	
Course Assessment Methods	**External**		
		—--	**----**
	Internal	**PR (25 Marks)**	**--**
Prerequisites	**Basic terms like heat, work and energy etc**		

Guidelines for Laboratory Conduction

i. **The production drawing of a job with all linear and geometric dimensions, Raw material, size and shape, allowances provided.**
ii. **List of tooling required.**
iii. **Process plan to complete the job.**
iv. **General safety instructions**

Course Objectives

1	**To understand the construction and working of machine tools and functions of its parts.**
2	**To develop the skill through hands-on practices using hand tools, power tools, machine tools in manufacturing and assembly shop leading to understanding of a production processes.**
3	**To understand workshop layout and safety norms.**

Course Outcomes

CO1	**To comprehend the safety measures / norms to be followed while using the cutting tools / Machine tools in workshop.**
CO2	**To Study and understand working functions of various machine tools like lathe, Milling, Drilling, Shaper / grinding to manufacture a job.**
CO3	**To Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping, Drilling, Milling and shaping / Grinding.**
CO4	**To study and Practice on various manufacturing processes including fitting, carpentry, sheet metal, welding and machine tools.**

Guidelines for Laboratory Conduction

i. **1 st on importance of workshop practical and shop floor safety norms**

ii. **2 nd to 6th Sessions are about demonstration of machine tools (Any 4)**

iii. **iii. 7 th to 9th on making utility job (Any 2)**

iv. **iv. 10th& 11th session on preparation of workshop layout and safety norms.**

Contents

Experiment:1	Introduction to Workshop Layout, various shops and its safety norms.
Experiment:2	Demonstration and working of center lathe Demonstration on various functions of lathe parts: Headstock, Tailstock, Carriage, Lead screw, All geared Mechanism, Apron mechanism etc.
Experiment:3	Demonstration of Lathe operations: Step turning and facing, drilling operation on a Mild Steel cylindrical job on centre lathe. Understanding the concept of speed, feed and depth of cut.
Experiment:4	Demonstration of Drilling machine Demonstration on construction of Radial drilling machine, Tool holding devices, Concept of speed, feed and depth of cut.DemonstrationofDrillingmachine
Experiment:5	Demonstration on Milling machine Demonstration on construction, table movements, indexing and tooling of milling machines.
Experiment:6	Demonstration of Shaper/Grinding machine (Any one) Shaper: Crank and slotted link mechanism, Work feed mechanism Grinding: Surface grinder/Cylindrical grinding machine, Mounting of grinding wheel
Experiment:7	Job of Carpentry Introduction to wood working, kinds of woods, hand tools & machines, Types of joints, wood turning. Pattern making, types of patterns and its allowances.

Experiment:8	Job involving fitting operations to size, male-female fitting with drilling and tapping operation on Mild Steel plate; Introduction to marking, cutting and sawing, sizing of metal, shearing, Concept of fits and interchangeability, selection of datum and measurements.
Experiment:9	Job using sheet metal / Welding with riveting/welding/brazing/soldering (at least one temporary and one Permanent joint either using resistance welding/Arc welding); Introduction to sheet metal operations: punching, blanking, bending, drawing.
Experiment:10	Prepare a Layout of Workshop To prepare a work shop layout.
Experiment:11	Collection of information about safety norms in any one of the following type of industry: Metalworking/Chemical/Cement/Pharmaceuticals/Defense/Atomic energy/Aerospace /Marine/Construction/Railway etc.

TextBooks	**Author**	**Title ofBook**	**Publication**
T1	**John,K.C.,(2010)**	**Mechanical WorkshopPractice**	**Prentice HallPublication, NewDelhi**
T2	**Chaudhari and Hajra**	**Elements of Workshop Technology Volume I and II**	**Media Promoters andPublishers,Mumbai**

Self-Learning Facilities, Web Resources, Research papers	**Basic Mechanisms and Machine Elements**
Contents beyond Syllabus	**Radial Drilling Machine/ Foundry Operations**
Additional Experiments	-----
Bridging Courses	------
Presentations	**Images and videos of machining operations and their applications**

Engineering Chemistry

Course Title: FE Engineering Chemistry		**Course Number: 2019 COURSE**	**Course Code: 107009**
Year: 2020-21		**Semester: I/II**	
Designation of Course		Professional Core	
Teaching Scheme: 4 Hrs/Week		**Tutorial:** Nil	
Course Assessment	**Direct External methods**	In-semester Examination: 30 Marks	End Semester Examination: 70 Marks
			PR : 25 Marks

Methods	**Direct Internal Methods**	Assignments, Tutorials, Subjective Test	Presentations
Prerequisites:	Types of titrations, volumetric analysis, structure property relationship, types of crystals, periodic table, classification and properties of polymers, electromagnetic radiation, electrochemical series.		
Course Objectives			
1	To understand technology in analysis and improving quality of water as commodity.		
2	To acquire the knowledge of electroanalytical techniques that facilitates rapid and precise understanding of material.		
3	To understand structure, properties and applications of speciality polymers and nanomaterial.		
4	To study conventional and alternative fuels with respect to their properties and applications.		
5	To study spectroscopic techniques for chemical analysis.		
6	To understand corrosion mechanism and prevention methods for corrosion control.		
Course Outcomes: On completion of the course, learner will be able to…			
CO1	Describe advance engineering materials for various engineering applications		
CO2	Illustrate different methodologies for water treatment, analysis of fuel and corrosion and control..		
CO3	Explain electroanalytical and spectroscopic techniques for material/chemical analysis.		
CO4	Solve the problems based on the learnt chemistry principles.		
Course Contents			
Unit-I	**Water Technology(08Hrs)**		
	Impurities in water, Hardness of water: types, units and numericals, determination of hardness (by EDTA method using Molarity concept) and Alkalinity, Numericals. Ill effects of hard water in boilers- Priming and foaming, Boiler corrosion, caustic embrittlement, Scale and sludge. Water treatment: i) Zeolite method &numericals. ii) Demineralization. Purification of water: Reverse Osmosis and Electrodialysis.		
	Practical		

	To determine hardness of water by EDTA method.
	To determine alkalinity of water.
Unit-II	**Instrumental Methods of Analysis (08Hrs)**

	Introduction: Types of reference electrode (calomel electrode), indicator electrode (glass electrode), ion selective electrode: ion selective membranes such as solid membrane, enzyme based membrane and gas sensing membrane. [A] Conductometry: Introduction, conductivity cell, conductometric titrations of acid versus base with titration curve. [B] pHmetry: Introduction, standardization of pH meter, pH metric titration of strong acid versus strong base with titration curve.
	Practical To determine strength of strong acid using pH meter
	Titration of a mixture of weak acid and strong acid with strong base using conductometer
Unit-III	**Engineering Materials (08Hrs)**
	A] Speciality polymers: Introduction, preparation, properties and applications of the following polymers: 1. Engineering Thermoplastic: Polycarbonate, 2. Bio-degradable polymers: Poly (hydroxybutyrate-hydroxyvalanate), 3. Conducting Polymer: Polyacetylene, 4. Electroluminescent polymer: Polyphenylenevinylene, 5. Polymer composites: Fiber reinforced plastic (FRP)- Glass reinforced and Carbon reinforced polymer composite [B] Nanomaterials: Introduction, classification of nanomaterials based on dimensions (zero dimensional, one-dimensional, two-dimensional and three-dimensional), structure, properties and applications of graphene and carbon nanotubes, quantum dots (semiconductor nanoparticles).
	Practical
	Preparation of polystyrene/phenol-formaldehyde/urea-formaldehyde resin To determine molecular weight/radius of macromolecule polystyrene/ polyvinyl alcohol by viscosity measurement. Colloidal synthesis of 2-6 or 3-5 semiconductor quantum dots nanoparticles
Unit- IV	**Fuels (08Hrs)**

	Introduction (definition, classification of fuel based on chemical reactions and characteristics of an ideal fuel), Calorific value (CV): Higher calorific value (HCV) and Lower calorific value (LCV), Determination of Calorific value: Principle, construction and working of Bomb calorimeter and Boy's gas calorimeter and numericals, Solid fuel: Coal: Analysis of Coal- Proximate and Ultimate analysis, numericals, Liquid fuel: Petroleum: Refining of petroleum /crude oil and composition,
	boiling range and uses of various fractions, Gaseous fuel: Composition, properties and applications of CNG. Hydrogen gas as a future fuel Alternative fuels: Power alcohol and biodiesel.
	Practical
	Proximate analysis of coal
Unit- V	Spectroscopic Techniques (08Hrs)
	[A]UV-Visible Spectroscopy: Introduction, interaction of electromagnetic radiation with matter, statement of Beer's law and Lambert's law, absorption of UV radiation by organic molecule leading to different electronic transitions, terms involved in UV- visible Spectroscopy- chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic shift, Instrumentation and basic principle of single beam spectrophotometer, applications of UV-visible spectroscopy. [B] Infra red Spectroscopy: Introduction, Principle of IR Spectroscopy, types of vibrations: Stretching (symmetric and asymmetric) and bending (scissoring, rocking, wagging and twisting), conditions of absorption of IR radiations, vibration of diatomic and polyatomic molecules. Instrumentation with block diagram. Parts of IR spectrum, fundamental group region, fingerprint region, applications of IR spectroscopy.
	Practical
	To determine maximum wavelength of absorption of CuSO4/FeSO4/ KMnO4, verify Beer's law and find unknown concentration of given sample.
Unit-VI	Corrosion Science(08Hrs)

	Introduction, Types of corrosion – Dry and Wet corrosion, mechanism of dry corrosion, nature of oxide films and Pilling-Bedworth's rule, wet corrosion – mechanism: hydrogen evolution and oxygen absorption, galvanic cell corrosion, concentration cell corrosion, Factors influencing rate of corrosion. Methods of corrosion control and prevention: cathodic and anodic protection, metallic coatings and its types, surface preparation, methods to apply metallic coatings-hot dipping, cladding, electroplating, cementation.
	Practical
	To coat copper and zinc on iron plate using electroplating.

Text Books	**Author**	**Title of Book**	**Publication**
T1	O.G.Palanna	Engineering Chemistry	TataMcGraw Hill Education Pvt.LLtd..
T2	Dr.S.S.Dara, Dr.S.S.Umare	A Textbook of Engineering Chemistry	S.Chand& Company Ltd
T3	Dr.Sunita Rattan	Textbook of Engineering Chemistry	S. K. Kataria& Sons
Reference Books			
R1		Engineering Chemistry	Wiley India Pvt., First edition 2011
R2	Shriver and Atkins,	Inorganic Chemistry,5e	Oxford University Press
R3	S.M.Khopkar	Basic Concepts of Analytical Chemistry,2e	New Age International Publishers.
R4	G. R. Chatwal& S. K. Anand	Instrumental Methods of Chemical Analysis	Himalaya Publishing House
R5	P. S. Kalsi	Spectroscopy of organic compounds, 2 ed,	New Age-International Ltd., Publisher
R6	V. R. Gowarikar, N. V. Viswanathan, jayadevSreedhar,	Polymer Science,	Wiley Eastern Limited
Self-Learning Facilities, Web Resources, Research papers for reference	V lab Amrita University		

Contents beyond Syllabus/ Additional Experiment	Demonstration practical: Effect of pH on Corrosion
Tutorials	▪ Numerical based on Hardness of water.
	▪ Numerical based on Alkalinity of water and Zeolite method.
	▪ Numerical based on Proximate and Ultimate Analysis of Coal.
	▪ Numerical based on Bomb & Boy's Gas Calorimeter.

QUESTION BANK

Unit No I WATER TECHNOLOGY AND GREEN CHEMISTRY

Q. 1 What is Hardness of water? Give reasons behind it and explain EDTA method for the determination of Hardness of water.

Q. 2 What are the Scales & Sludge? Give their formation, disadvantages and preventive measures in boiler.

Q. 3 Explain causes, disadvantages, and prevention of
a) Priming and Foaming in boiler.
b) Caustic embrittlement in boiler.
c) Boiler corrosion.

Q. 4 Describe Demineralization (Ion Exchange) method for softening of hard water.

Q. 5 What are Zeolites? Explain zeolite process of softening of hard water. Give advantages and disadvantages.

Q. 6 Explain the method of internal treatment of boiler feed water.

Q. 7 Explain any six principles of Green Chemistry.

Q. 8 State disadvantages in traditional synthesis route and advantages of green synthesis of Adipic acid, Polycarbonate and Indigo dye

Q. 9 Explain Electro dialysis and Reverse osmosis process for softening of hard water.

Unit No II ELECTROANALYTICAL TECHNIQUES

Q. 1 State the reference electrode and standard electrode used in pHmetry, Potentiometry and Conductometry

Q. 2 What is the reference electrode? Draw neat labeled diagram of Glass electrode and Calomel electrode. Give it's representation.

Q. 3 What are ion selective electrode?Explain composition and working of solid state membrane electrode with the help of example and diagram.

Q. 4 Define specific conductance, equivalence conductance and molar conductance.

Q.5 Explain the pH metric titration of mixture of weak acid – strong acid against standard alkali giving chemical reactions, procedure, titration curve and calculations..

Q.6 Explain the conductometric titration with titration curve for

a) Strong acid – Strong base titration b) Weak acid – Weak base titration

c) Strong acid – Weak base titration d) Weak acid – Strong base titration

Unit No III ENGINEERING MATERIALS

Q. 1 Define biodegradation of polymers. State favorable structure of polymer for biodegradation. Give structure of PHBV.

Q. 2 Explain FRP with respect to their properties and applications.

Q. 3 Write a note on Conducting polymer.

Q. 4 Write a note on Electroluminescent polymer

Q. 5 Define thermoplastic polymer.Write a note on Polycarbonate

Q. 6 What are nanomaterials?Explain the factors responsible for different properties of nanomaterial than their bulk materials.

Q. 7 How are nanomaterials classified?

Q. 8 Explain different biological and medical applications of Quantum dots

Q. 9 Explain structure, properties and application of graphite.

Q. 10 What are carbon nanotubes? Give it's classification and applications

Unit No IV FUEL AND COMBUSTION

Q. 1 Define Gross/higher calorific value and justify the relationship between GCV and NCV of the fuel, if fuels contain hydrogen.

Q. 2 Draw neat labeled diagram and give the construction, working of Bomb calorimeter to determine GCV of fuel. State the formula with correction to calculate GCV.

Q. 3 How calorific value can be determined by using Boy's Gas calorimeter.

Q. 4 Explain proximate analysis of coal.

Q. 5 What is Ultimate analysis? Explain determination of percentage of carbon and hydrogen, nitrogen with principle, chemical reaction and formulae.

Q. 6 Write a note on refining of petroleum.

Q. 7 Explain principle involved in fractional distillation.Give the composition and boiling range of fractions obtained during fractional distillation.

Q. 8 What is power alcohol? Give it's preparation with reactions advantages and disadvantages.

Q. 9 What is Biodiesel? Explain the reaction with conditions involved. Give advantages and disadvantages.

Q. 10 Give composition, properties and applications of- i) CNG ii) LPG

Q.11 How is hydrogen manufactured commercially?

Q.12 Give a note on "storage of hydrogen" and difficulties encountered.

Unit No V SPECTROSCOPIC TECHNIQUES

Q. 1 `Explain the following terms with suitable example
i) Chromophore ii) Auxochrome iii) Bathochromic shift iv) Hyperchromic shift

Q. 2 State and derive Beer-Lambert's law.

Q. 3 Give applications of UV-Visible spectrophotometer

Q. 4 Explain different types of electronic transitions occurring in organic molecules on absorption of UV-Visible radiations.

Q. 5 Explain principle and instrumentation of UV-Visible spectrophotometer.

Q.6 Mention the IR region waves. State the principles involved in IR Spectroscopy.

Q.7 What is the finger print region? Give its importance.

Q.8 Explain instrumentation of IR Spectroscopy

Q.9 Give the applications of IR Spectroscopy.

Q.10 Give the different kind of vibrations mode in molecules with example of water, CO_2,

CH_4, C_6H_6.

Unit No VI CORROSION SCIENCE

Q. 1 Define corrosion and explain dry corrosion due to oxygen. Explain with examples how nature of oxide film affects corrosion.

Q. 2 What is electro-chemical corrosion? Explain electro-chemical corrosion by evolution of hydrogen gas and absorption of oxygen gas.

Q. 3 Explain various factors affecting rate of corrosion.

Q. 4 Explain various cathodic protection methods to control corrosion with principle, figures and applications.

Q. 5 Differentiate between i) Anodic coating and Cathodic coating.
ii) Glavanizing and Tinning

Q. 6 Explain powder coating method of corrosion.

Q. 7 What are types of metallic coatings? Which is preferred? Why?

Q. 8 What is Pilling – Bedworth rule? Explain it with examples.

Q. 9 Describe Anodic protection of metal for corrosion control.

Q. 10 What is Electroplating? Explain process with diagram and applications of electroplating.

Progressive Education Society's

Modern College of Engineering

DEPARTMENT OF FIRST YEAR ENGINEERING

ENGINEERING MECHANICS

<table>
<tr><td colspan="2">Course Title : ENGINEERING MECHANICS</td><td colspan="2">Course Code :101011</td></tr>
<tr><td colspan="2">Year: FirstYearEngg. (FE)</td><td colspan="2">Semester: I &II</td></tr>
<tr><td colspan="2">Designation Course</td><td colspan="2">Basic Subject for all Branches</td></tr>
<tr><td colspan="2">Teaching Scheme:3Hrs/Week</td><td colspan="2">Practical : 2Hrs/Week per batch</td></tr>
<tr><td rowspan="3">Course Assessment Methods</td><td rowspan="2">Direct methods</td><td>In-semesterExam: 30 Marks</td><td>EndSemesterExam: 70 Marks</td></tr>
<tr><td colspan="2">TW: 25 Marks</td></tr>
<tr><td>IndirectMethods</td><td>Class Tests</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="3">12th Physics, 12th Maths</td></tr>
<tr><td colspan="4">Course Objectives</td></tr>
<tr><td>1</td><td colspan="3">To impart knowledge about force systems and methods to determine resultant centroid and moment of inertia</td></tr>
</table>

2	**To teach methods to calculate force of friction**
3	**To impart knowledge to determine reaction of beams, calculate member forces in trusses, cables and frames using principles of equilibrium**
4	**To teach space force systems**
5	**To train students to solve problems related to particle mechanics using principles of kinematics, kinetics and work power energy**
Course Outcomes: On completion of the course, learner will be able to -	
CO1	**EXPLAIN** the characteristics of force, force systems and its application.
CO2	**SOLVE** engineering problems to find centroid, moment of inertia and friction.
CO3	**APPLY** principles of equilibrium to find reactions of beams and forces in space.
CO4	**ANALYZE** trusses, frames for finding member forces and apply principles of equilibrium to calculate forces in cables.
CO5	**CONSTRUCT** a solution to find position, velocity and acceleration of particles using principles of kinematics.
CO6	**SOLVE** problems based on kinetics and Work, Power, Energy.
Course Contents	
Unit-I	**Resolution and Composition of Forces**

	• Principle of statics, Force system, resolution and composition of forces, Resultant of concurrent forces. • Moment of a force, Varignon's theorem, Resultant of parallel force system, Couple, Equivalent force couple system, • Resultant of parallel general force system
	Practicals
	· Verification of law of parallelogram of forces/polygon of forces · Graphical Solution to determine unknown forces of concurrent force system · To determine the resultant of general force system

Unit-II	**Distributed Forces and Friction**
	• Moment of area, Centroid of plane lamina and wire bends, Moment of Inertia. Friction-Laws of friction, Application of friction on inclined planes, Wedges and ladders friction • Application to flat belt
	Practicals
	· Determination of coefficient friction of belt/inclined plane
Unit-III	**Equilibrium**

	• Free body diagram, • Equilibrium of concurrent, parallel forces in a plane Equilibrium of general forces in a plane • Equilibrium of three forces in a plane, and compound beams, • Type of supports and reaction, • Forces in space, Resultant of concurrent and parallel forces in a space, Equilibrium of concurrent and parallel forces in a space.
	Practicals
	· To determine the support reaction of simple/compound beams. · To determine forces in members of the space force system.
Unit-IV	**Analysis Of Structures**
	• Two force member, • Analysis of plane trusses by Method of joints, Analysis of plane trusses by method of section, Analysis of plane frames, • Cables subjected to point load multi force members.
	Practicals
	· Graphical Solution to determine the forces in the member of the

	plane truss
Unit-V	**Kinematics of Particle**
	• Kinematics of linear motion- Basic concepts Equation of motion for constant acceleration Motion Under gravity • Variable acceleration motion curves • Kinematics of curvilinear motion- Basic Concepts Equation of motion in Cartesian coordinates Equation of motion in path coordinates • Equation of motion in polar coordinates Motion of projectile.
	Practicals
	· To study the curvilinear motion · Graphical Solution to determine velocity and acceleration of particle from given s-t diagram
Unit-VI	**Kinetics ofParticle**

	• Kinetics- Newton's Second Law of motion Application of Newton's Second Law. • Work, power, energy, conservative and non-conservative forces Conservation of energy for motion of particle, • Impulse, Momentum, Direct central impact. • Coefficient of restitution, Impulse Momentum principle of particle.
	Practicals
	• Determination of coefficient of restitution

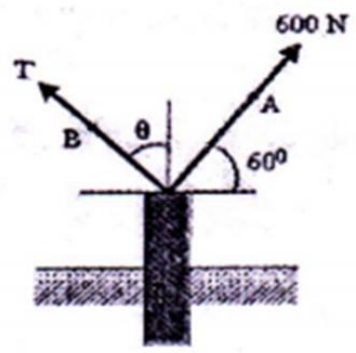
Text Books	**Author**	**Title of Book**	**Publication**
T1	Beer & Johnston	Vector	McGraw-
T2	R. C. Hibbeler	Engineering Mechanics	Pearson Education
Reference Books			
R1	Timoshenko & Young	Engineering Mechanics	McGraw-Hill Pub.
R2	Meriam & Craige	Engineering Mechanics	John Willey Pub.

R3	F. L. Singer	Engineering Mechanics	Harper & Row Pub.
R4	Boresi& Schmidt	Engineering Mechanics	Brooks/Cole Pub.
Self-Learning Facilities, Web Resources, Research papers for reference	**www.nptel.ac.in** **www. Howstuffworks.com**		
Contents beyond Syllabus	**Nil**		
Additional Experiments	**Nil**		
Bridging Courses	**Nil**		
Tutorials	Unit I: - Resolution and Composition of Forces Unit II: - Distributed Forces and Friction Unit III: - Equilibrium Unit IV: - Analysis of Structures		

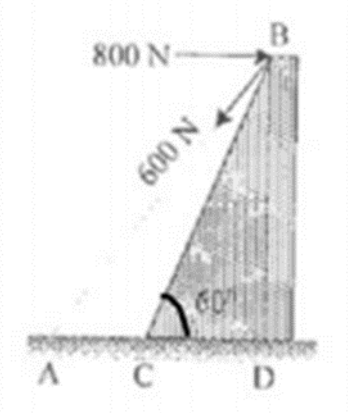
	Unit V: - Kinematics of Particle Unit VI: - Kinetics of Particle
Presentations	**Nil**

Question Bank - Unit I

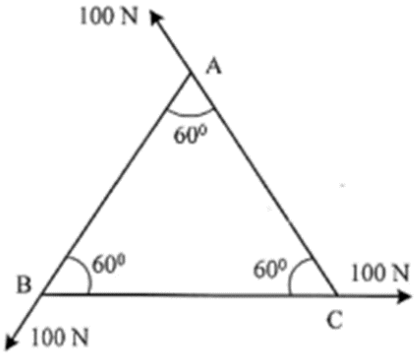
1	The post is to be pulled out of the ground using ropes A and B as shown in fig. Rope is subjected to a force of 600N and directed at 60 degrees from horizontal. If the resultant force acting on the post is 1200 N vertically upward, determine the force T in the rope B and the corresponding angle θ.



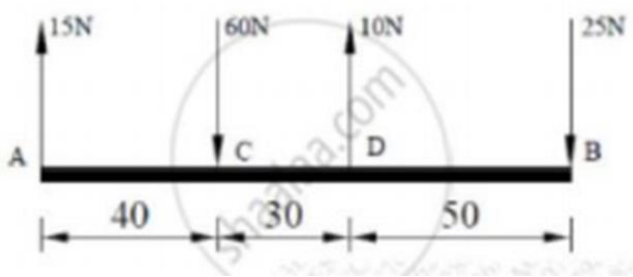
2	Combine the two forces 800 N and 600 N which act on the fixed dam structure at B, into a single equivalent force R if AC = 3.0m, BC = 6.0m, angle BCD = 60 degree, Refer the figure given below.

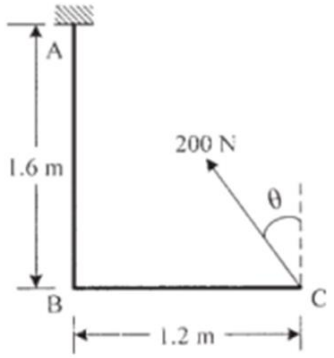


3	Determine the magnitude and direction of resultant with reference to point A for the force system as shown in fig. if the side of the equilateral triangle is 1m.

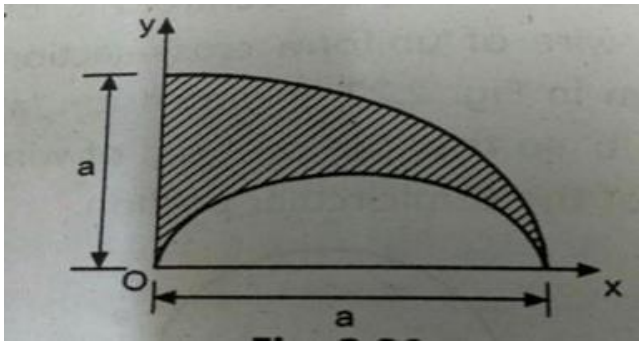


4	Determine the resultant of the parallel force system and locate the same with respect to point C. All distances are in mm.

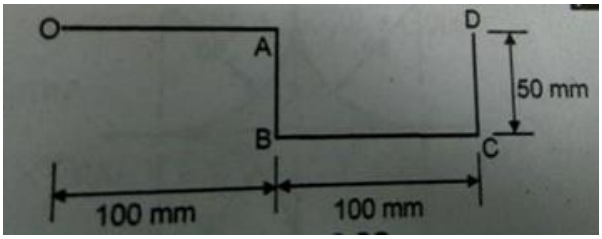


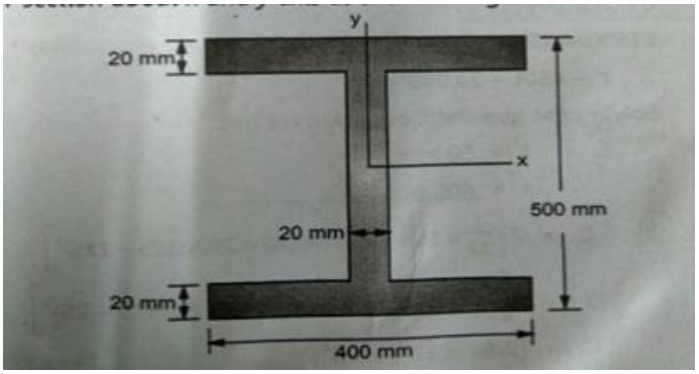
5	The lever ABC fixed at A shown in Figure is subjected to a 200 N force at C at θ= 30 degree. Find the moment of this force about A. Also find the value of θ for which the moment about A is Zero.
	

Question Bank - Unit II

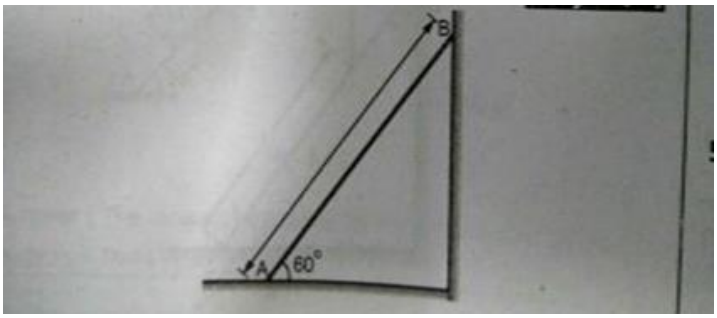
1	Locate the centroid C of the shaded area obtained by cutting a semicircle of diameter a from the quadrant of a circle of radius a as shown in fig. with respect to origin O.
	

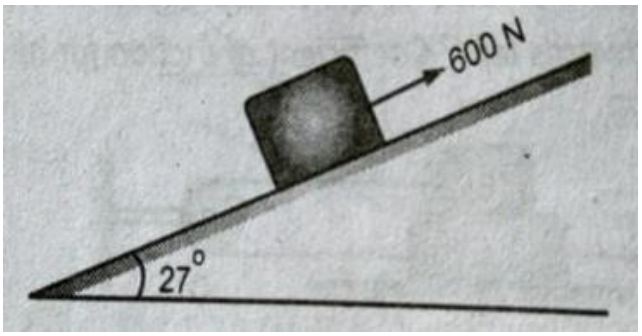
2	A thin rod is bent into a shape OABCD as shown in Fig. Determine the centroid of the bent rod with respect to origin O.

3	Determine the moment of inertia for the I-section about X and Y axis as shown in the fig**.**
	

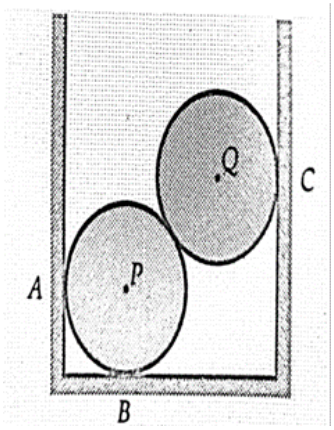
4	The 15 m ladder has a uniform weight of 80 N and rest against the smooth wall at B as shown in fig. If the coefficient of static friction is 0.4. Determine if the ladder will slip?

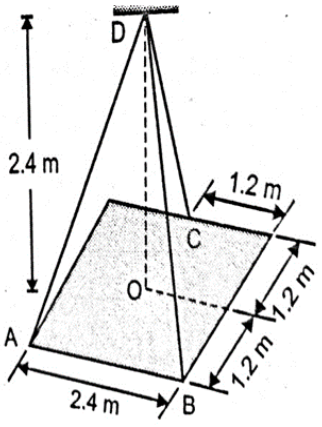
	

5	A body of weight 1000 N is pulled upon an inclined plane by a force of 600 N. The inclination of the plane is 27 degrees to the horizontal and force is applied parallel to the plane. Determine the angle of friction.
	

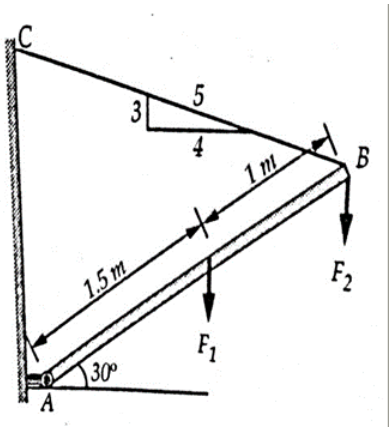
Question Bank - Unit III

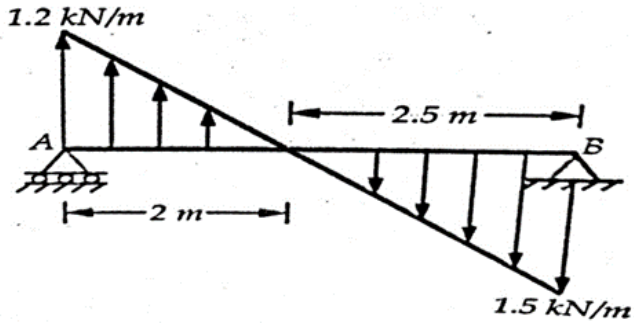
1	Two spheres P and Q each of weight 50N and a radius of 100mm rest in a horizontal channel of width 360mm as shown in figure. Determine the reaction at the point of contact A, B and C.

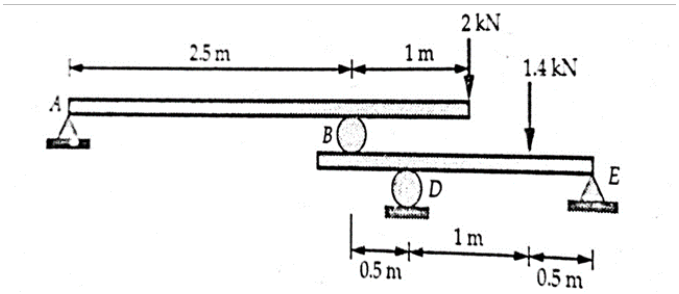
2	The square steel plate has a mass of 1500kg with a mass center at its center G. Calculate tension in each of three cables with which the plate is lifted while remaining horizontal.
	

3	The boom is intended to support two vertical loads F1 and F2 as shown in figure. If the cable CB can sustain a maximum load of 1500N before it fails. Determine the critical loads if F1=2F2. Also determine the reaction at pin support A.

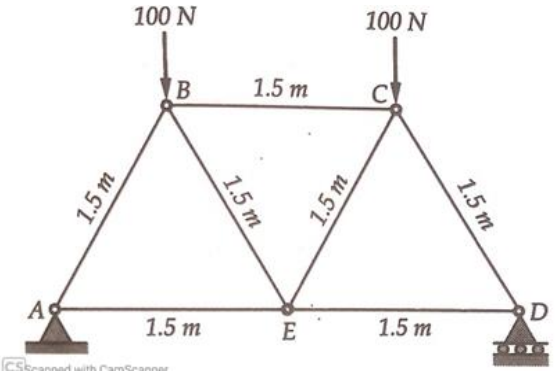
	

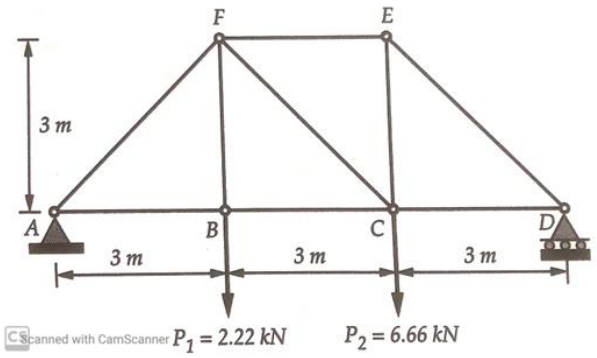
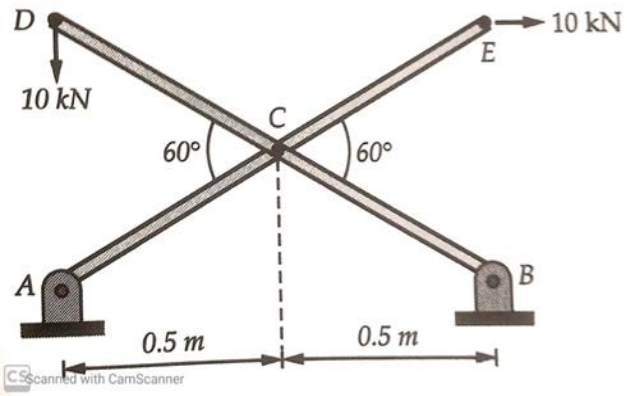
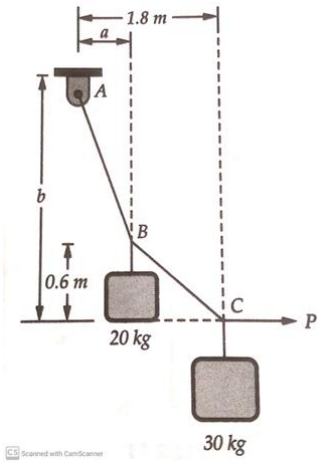
4	The beam AB with pin at B and roller at A is loaded as shown in figure. Find reactions that support A and B.
	

5	Find support reactions at support D and E for the beam system as shown in figure.

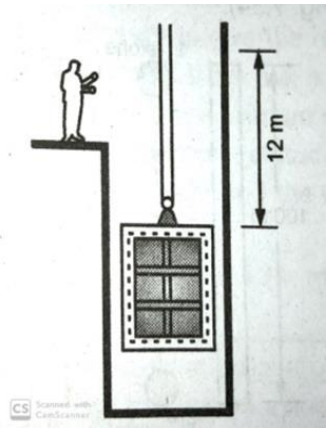
Question Bank - Unit IV

1	What are the assumptions for analysis of truss? How truss is classified depending on the no. of members required for stability?
2.	Determine the forces in the members of the truss loaded and supported as shown in given fig. Tabulate the result with magnitude and nature of force in the members. 

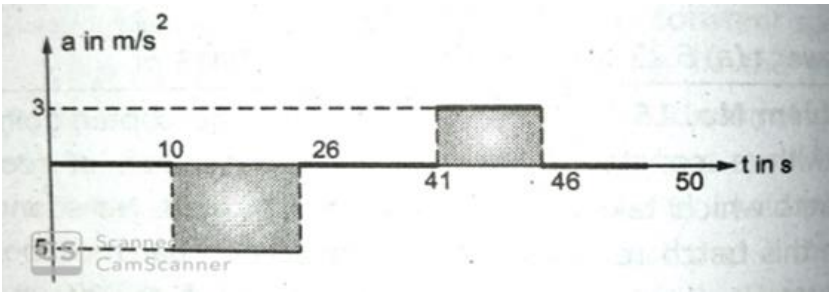
3.	Determine the force in members FE, FC and BC of the truss using the method of sections and state if the members are in tension or compression. Given P_1 = 2.22 kN and P_2 = 6.66 kN. Refer given fig: 
4.	Determine the horizontal and vertical component of reactions at A and B for the frame loaded and supported as shown in fig. 
5.	Cable ABC supports two boxes as shown in fig. Knowing that b = 2.7 m, determine the required magnitude of the horizontal force P and the corresponding distance a. 

Question Bank - Unit V

1	A motorist traveling at 54kmph when he observes a traffic light, 240m ahead of him, turns red. The traffic light is timed to stay red for 24sec. If the motorist wishes to pass the light without stopping just as it turns green again, determine the required uniform deceleration of the car and also the speed with which he crosses the light signal.

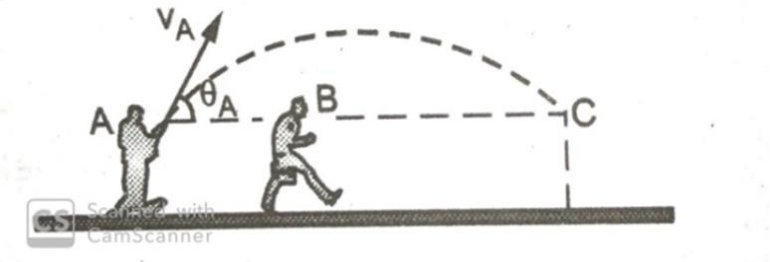
2	An elevator starts from rest and moves upwards, accelerating at a rate of 1.2m/s^2, until it reaches a speed of 7.8 m/s, which is then maintained. Two seconds after the elevator begins to move, a man standing 12m above the initial position of the top of the elevator throws a ball upward with an initial velocity of 20m/s. Determine when (after the elevator starts) the ball will hit the elevator.
	

3	A particle moves in a straight line with the acceleration shown. If x = -540m and v = 60m at t =0, find the total distance traveled by the particle when t=50s.



4	At a given instant, a particle has the following position, velocity and acceleration components relative to fixed X-Y coordinate system x=4m, y=2m, $\dot{x}$=2 m/s, $\dot{y}$ = -2m/s, $\ddot{x}$ = -5m/s^2, $\dot{y}$ = 5m/s^2. Determine all the values related to polar coordinates.

5	The baseball player A hits the baseball at v_A = 16m/s and θ_A = 60^o from the horizontal. When the ball is directly overhead of player B, he begins to run under it. Determine the constant speed at which B must run in order to make the catch at the same elevation at which the ball was hit.



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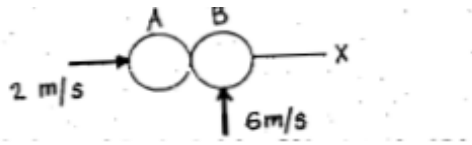
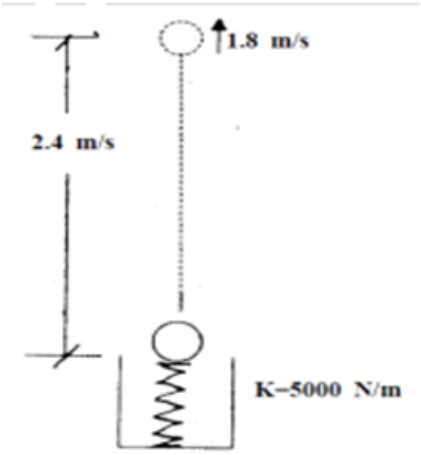
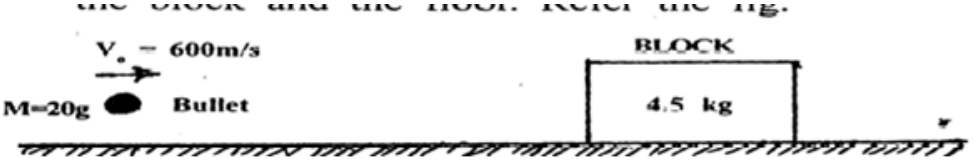
Question Bank - Unit VI

1	Two smooth identical balls strike each other as shown in fig, If value of e=0.8 ,determine their velocities after impact. 
2	The 50N ball is projected vertically from the tube by spring action (shown in figure 1b.) Determine how far the spring must be compressed to project the ball from compressed position to a height of 2.4m at which point, it has velocity 1.8 m/s. Assume K = 5000 N/m. 
3	A ball of 2kg weight is released from 3m on the horizontal floor. If e=0.8 what will be height it will rebounce back after a) 1st rebounce b) 4th rebounce c)10th rebounce

4	Two identical balls of masses 20kg resting on a horizontal table, if one is hit by a stick will have velocity of 10 m/s just before collision with another ball, which is at the rest .If collision is perfectly elastic, find velocities after collision.
5	A 20g bullet is fired with a velocity of magnitude V=600 m/s. into a 4.5kg block of wood which is stationary. Knowing that the coefficient of kinetic friction between the block and floor is 0.4 , Determine i) How far the block will move. ii)The percentage of the initial energy lost in friction between the block and the floor. 

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Assessment Tools of EM

Unit. No	Name of the unit	Assignments	Unit Test	Practical
1	Resultant of Coplanar force System	√	√	√
2	Distributed forces and Friction	√	√	√
3	Equilibrium of force system	√	√	√
4	Analysis of structure	√	√	√
5	Kinematics of Particle	√	√	√
6	Kinetics of Particle	√	√	√

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DEPARTMENT OF FIRST YEAR ENGINEERING

Engineering Mathematics-II

Faculty: Prof

	Lecture	Tutorial	Practical
Weekly work Load (in Hrs.)	**4**	**1**	**0**

In Sem	Theory	Term Work	Total Marks	Credit
30	**70**	**25**	**125**	**5**

1.1 Syllabus

Unit No.	Course Content	Hours
Unit-I	First Order Ordinary differential Equations: Exact differential equations, Equations reducible to exact form. Linear differential equations, Equations reducible to linear form, Bernoulli's equation.	**08**
Unit-II	Applications of Differential Equations: Applications of Differential Equations to Orthogonal Trajectories, Newton's Law of Cooling, Kirchhoff's Law of Electrical Circuits, Rectilinear Motion, Simple Harmonic Motion, One dimensional Conduction of Heat.	**08**
Unit-III	Integral Calculus: Reduction Formulae, Beta and Gamma functions, Differentiation Under Integral Sign and Error functions.	**08**
Unit-IV	Curve Tracing: Tracing of Curves – Cartesian, Polar and Parametric curves, Rectification of curves.	**08**
Unit-V	Solid Geometry: Cartesian, Spherical polar and Cylindrical coordinate systems, Sphere, Cone and Cylinder.	**08**
Unit-VI	Multiple Integrals and their Applications: Double and Triple integrations, Change of order of integration, Applications to find Area, Volume, Mass, Centre of Gravity and Moment of Inertia.	**08**

1.2 Course Objectives

To make the students familiarize with concepts and techniques in Calculus, Fourier series and Matrices. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

1.3 Course Outcome(Cos)

The students will be able to learn

CO1: Solve first order first degree differential equations for real world problem.
CO2: Solve definite integrals using advanced techniques which are needed in evaluating multiple integrals and their applications.
CO3: Analyze curve points and trace curve to find its arc length.
CO4: Apply solid geometry to find equations of sphere, cone and cylinder.
CO5: Solve multiple integrals to find different parameters

1.4 Text Books

According to SPPU Syllabus		
Sr. no.	**Book Name**	**Author Name & Publication**
1	Higher Engineering Mathematics	B. V. Ramana ,Tata McGraw Hill
2	Higher Engineering Mathematics	B. S. Grewal (Khanna Publication, Delhi)

1.5 Reference Books

Other References		
1	Advanced Engineering Mathematics	Erwin Kreyszig (Wiley Eastern Ltd.)
2	Advanced Engineering Mathematics	M. D. Greenberg (Pearson Education)
3	Advanced Engineering Mathematics	Peter V. O'Neil (Thomson Learning).
4	Thomas' Calculus	George B. Thomas, (Addison-Wesley, Pearson)
5	Applied Mathematics (Vol. I & Vol. II) by	P.N.Wartikar and J.N.Wartikar Vidyarthi Griha Prakashan, Pune.
6	Differential Equations	S. L. Ross (John Wiley and Sons)

1.6 Teaching Plan

Sr No.	Unit	Broad topic to be covered	Books Referred	Total Lectures planned
1	I	Introduction of Differential Equation(DE) , Definition of DE and its Order , Degree , Formation of ordinary DE Solution of first order & first degree DE , Solution of DE :Variable separable form, Reducible to VS), Homogeneous DE, Exact DE, Linear DE, Reducible to Linear DE	Erwin Kreyszig (Wiley Eastern Ltd.), Peter V. O'Neil (Thomson Learning).	9
2	II	Orthogonal Trajectory Newton's law of Cooling Kirchhoff's law of Electrical circuits. Fourier Law of Heat Conduction Rectilinear Motion Simple Harmonic Motion Problems on Chemical Engineering	Erwin Kreyszig (Wiley Eastern Ltd.), Peter V. O'Neil (Thomson Learning).	9
3	III	Reduction Formulae. Gamma function Beta function Differentiation Under Integral Sign Rule I,II(Leibnitz's Rule) Error Function	Erwin Kreyszig (Wiley Eastern Ltd.), Peter V. O'Neil (Thomson Learning). .	9
4	IV	Curve Tracing : Cartesian Curves Polar Curve Rose Curves Parametric Curves Rectification Of Curves	Erwin Kreyszig (Wiley Eastern Ltd.), Peter V. O'Neil (Thomson Learning).	9

5	V	Introduction of Solid Geometry: Cartesian, Spherical polar and Cylindrical Coordinate Systems,Touching sphere,Tangent plane Section of Sphere by Plane Orthogonal sphere, Great circle Cone and its examples Right Circular Cone and examples on Right Circular Cone Cylinder and its examples Right Circular Cylinder and examples on Right Circular Cylinder	Erwin Kreyszig (Wiley Eastern Ltd.), Peter V. O'Neil (Thomson Learning).	9

6	VI	Introduction of Double integral , Evaluation of Double Integration Transformation to polar Form Problems on Area Evaluation of Triple Integration Problems on Volume Mean Value , RMS Value Center of Gravity, Moment of Inertia	Erwin Kreyszig (Wiley Eastern Ltd.), P.N.Wartikar and J.N.Wartikar Vidyarthi Griha Prakashan, Pune.	9

1.7 Assessment Tools Details

Sem II

Sr. No.	Assessment Tool	Total in No (6 Units)	Marks scale down to
1	Assignment, Tutorial	12 12	10 10
2	Internal Tests Pre In Sem (T1) Pre End Sem (T2)	 1 1	 30 60
Total			100

Assessment Tools

Assignment – A1 to A12 (Sem II)

Tutorials- T1 to T12 (Sem II)

Class Tests – Pre In Sem (T1)

Pre End Sem (T2)

1.8 Scheduled of Assessment Tools

Course Name – Engineering Mathematics-I (107001)

Teaching Scheme: Theory –4 Hrs/Week, Tutorial- 1/Week
Marking Scheme: Theory Marks (100); ISE – 30 ESE – 70 TW –25

Detail Schedule/Plan of conduction of assessment tool

Sem II

Sr. No.	CO No.	Assessment Tool	Marks	Schedule
1	1 to 6	Assignments, Tutorials	10	May to July 2021
2	1 & 2	Pre In Sem (T1)	30	15 June 2021
3	1 to 6	Pre End Sem (T2)	60	28 July 2021

1.9 Practical Assessment

- NA –

1.10 Question Bannk

1. Unit-I :Differential Equation

1. $\left[x\ tan\ tan\left(\frac{y}{x}\right) - y\ sec^2\left(\frac{y}{x}\right)\right]dx + x\ sec^2\left(\frac{y}{x}\right)\ dy = 0$
2. $[y^4 - 2\ x^3y]dx + [x^4 - 2\ xy^3]\ dy = 0$
3. $\frac{dy}{dx} = \frac{y}{x} + tan\ tan\left(\frac{y}{x}\right)$
4. $[2x + 3y - 1]dx + [6x + 9y + 6]\ dy = 0$
5. $\frac{dy}{dx} = cos\ cos\ x\ \ cos\ cos\ y\ + sin\ sin\ x\ \ sin\ sin\ y$
6. $xy\frac{dy}{dx} = (1 - x^2)(1 + y^2)$
7. $\frac{dx}{dy} = \frac{x}{y} + cot\ cot\left(\frac{x}{y}\right)$
8. $\frac{dy}{dx} = e^{x-y} + x^3\ e^{-y}$
9. $x^4\ \frac{dy}{dx} + x^3y - sec\ sec\ (xy)\ = 0$
10. $\frac{dy}{dx} = \frac{x-y+3}{2x-2y+5}$
11. $(4 + e^{2x})\ \frac{dy}{dx} = ye^x$
12. $\frac{dy}{dx} = 1 - x\ tan\ tan\ (x - y)$

A. Solve the differential equations (EXACT or REDUCIBLE TO EXACT)

1. $(\ x^4e^x - 2mxy^2)\ dx + (\ 2mx^2y)dy = 0$
2. $dx + \frac{2xy}{x^2+y^2}dy = 0$
3. $[x^2 + \ y^2 + x]dx + \ xy\ \ dy = 0$
4. $(\ y^2e^{xy^2} + 4\ x^3)\ dx + (\ 2xye^{xy^2} - 3\ y^2)dy = 0$
5. $\frac{dy}{dx} = \frac{x^2+y^2+1}{2xy}$
6. $\frac{dy}{dx} = \frac{x+y-2}{y-x-4}$
7. $2y\ dx + \ [2xlog\ x - xy]\ dy = 0$
8. $\frac{dy}{dx} = \frac{2x-3y+1}{3x+4y-5}$
9. $y\ log\ log\ y\ \ dx + \ [x - log\ log\ y\ ]\ dy = 0$
10. $\frac{dy}{dx} = \frac{1+y^2+3x^2y}{1-2xy-x^3}$
11. $(1 + xy)y\ dx + (1 - xy)x\ dy = 0.$
12. $x(x - y)\ \frac{dy}{dx}\ = y(x + y)$
13. $\frac{dy}{dx} = \frac{y+1}{(y+2)e^y - x}$
14. $\frac{dy}{dx} = \frac{tantan\ y\ - 2xy - y}{x^2 - xy\ + y}$
15. $\left[\frac{y}{(x-y)^2} - \frac{1}{2\sqrt{1-x^2}}\right]dx - \frac{x}{(x-y)^2}\ dy = 0$
16. $\frac{dy}{dx} = -\frac{4x^3y^2 + ycoscos\ (xy)}{2x^4y + xcoscos\ (xy)}$
17. $y(2\ x^2y + e^x)\ dx = (\ e^x + y^3)dy$
18. $(x\ sec^2y - x^2\ cos\ cos\ y\ )\ dy = (tan\ tan\ y\ - 3x^4)dx$
19. $(\ y^4 + 2y)\ dx + (x\ y^3 + 2y^4 - 4x)dy = 0$
20. $(\ x^2y + y^4)\ dx + (2\ x^3 + 4xy^3)dy = 0$

21. $(y^3 - 2x^2y)\,dx + (2xy^2 - x^3)dy = 0$
22. $(x^2y - 2xy^2)\,dx - (x^3 - 3x^2y)dy = 0$
23. $(x^2y^2 + xy + 1)ydx - (x^2y^2 - xy + 1)xdy = 0$
24. $(2x + e^x \log\log y)y\,dx + e^x\,dy = 0$
25. $(1 + xy^2)dx + (1 + x^2y)dy = 0$
26. $(1 + \log\log xy)dx + \left(1 + \frac{x}{y}\right)dy = 0$

B. Solve the differential equations (Linear or Reducible to linear)

1. $(1 - x^2)\frac{dy}{dx} = 1 + xy$
2. $\frac{dy}{dx} = x^3\cos^2 y - x\sin\sin 2y$
3. $x\frac{dy}{dx} + y = y^2\log\log x$
4. $\cos\cos y - x\sin\sin y\ \frac{dy}{dx} = \sec^2 x$
5. $x\cos\cos x\ \frac{dy}{dx} + (\cos\cos x - x \sin\sin x)y = 1$
6. $\frac{dy}{dx} + x\sin\sin 2y = x^3\cos^2 y$
7. $(1 + y^2) + \left(x - e^{-\tan^{-1}y}\right)\frac{dy}{dx} = 0.$
8. $\cos\cos x\frac{dy}{dx} + y = \sin\sin x$
9. $\frac{dy}{dx} + y\cot x = \sin\sin 2x$
10. $ye^{\frac{x}{y}}dx = \left(xe^{\frac{x}{y}} + y^2\right)dy$
11. $xy - \frac{dy}{dx} = y^3e^{-x^2}$
12. $3y^2\frac{dy}{dx} + 2xy^3 = 4xe^{-x^2}$

A. ORTHOGONAL TRAJECTORIES :-

1. Find the orthogonal trajectories of the family of $x^2 + cy^2 = 1$.
2. Find the orthogonal trajectories of the family of straight lines $y = mx$.
3. Find the orthogonal trajectories of the family of parabolas $y = ax^2$.
4. Find the orthogonal trajectories of the family of $r = a(1 - \sin\theta)$
5. Find the orthogonal trajectories of the circles defined by $r = a\cos\theta$ which all pass through the origin and have their centres on the initial line , a being the variable diameter.
6. Find the orthogonal trajectories of the family of $xy = c$
7. Find the orthogonal trajectories of the family of $y^2 = 4ax$.

B. HEAT FLOW:-

1. A pipe 10 cm in a diameter contains steam at $100^\circ C$.It coverd with asbestos, 5 cm thick,for which k=0.0006 and the outside surface is at $30^\circ C$.Find the amount of heat lost per hour from a meter long pipe.

2. A pipe 20 cm in a diameter contains steam at 150°C and is protected with a covering 5 cm thick for which $k = 0.0025$.It the temperature of the outer surface of the covering is40°C,find the temperature half-way through the covering under steady state conditions.
3. A steam pipe 20 cm in diameter is protected with a covering 6 cm thick for which the coefficient of thermal conductivity is k=0.003 cal/cm deg. sec in steady state .Find the heat lost per hour through a meter length of the pipe, if the surface of pipe is at 200°C and outer surface of the covering is at 30°C.
4. The inner and outer surface of a spherical shell are maintained at T_0 and T_1 temperature respectively. If inner and outer radii of the shell are r_0 and r_1 respectively and thermal conductivity of shell is k, find amount of heat loss from shell per unit time. Find also the temperature distribution through the shell.
5. A long hollow pipe has an inner diameter of 10 cm and outer diameter of 20 cm the inner surface is kept at 200°C and outer surface at 50°C. The thermal conductivity is 0.12. How much heat is lost per minute from a portion of the pipe 20 m long?

C. <u>NEWTON'S LAW OF COOLING:-</u>

1. A body originally at 85°C cools to 65°C in 25 minutes , the temperature of air being 40°C,what will be the temperature of the body after 40 minutes.
2. If the temperature of the body drops from 100°C to 60°C in one minute when the tempeature of the body surroundings is 20°C what will be the temperature of the body at the end of second minute?
3. A body at temperature 100°C is placed in a room whose temperature is 20°C and cools 60°C in 5 minutes. Find its temperature after a further interval of 5 minutes.
4. A body at temperature 80°F is placed in a room whose temperature is 50°F at time t=0 .At the end of 5 minutes the body was cooled to a temperature of 70°F. Find the time at which the temperature of body will be 60°F.
5. A metal ball is heated to a temperature of 100°C and at time $t = 0$ it is placed in water is maintained at 40°C.If the temperature of the ball is reduced to 60°C in 4 minutes, find the time at which the temperature of the ball is 50°C.
6. According to Newton's low of cooling, the rate at which a substance cools in moving air is proportional to the difference between temperature of substance and that of the air. If the temperature of the air is 30°C and substance cools from 100°C to 70°C in 15 minutes, find when the temperature will be 40°C.
7. Water at temperature 100°C is placed in a room whose temperature is 20°C and cools to 60°C in 5 minutes .Find its temperature after further interval of 3 minutes.

8. When thermometer placed in a hot liquid bath at temperature T, the temperature θ indicated by the thermometer rises at the rate of $T-\theta$.For bath at 95℃ , the temperature reads 15℃ at a certain instant (t=0) and 35℃ at t = 10 second. what will be its temperature at t= 20 sec ?
9. A body at temperature 100℃ is placed in a room whose temperature is 20℃ and cools 60℃ in 5 minutes. Find its temperature after a further interval of 3 minutes.
10. A body at temperature 100℃ is placed in a room whose temperature is 20℃ and cools 60℃ in 5 minutes. Find its temperature after 10 minutes.
11. A body originally at 80^0C cools to 60^0C in 20 20 minutes the temperature of air being 40^0C, what will be the temperature of the body after 40 minutes?
12. Temperature of water initially is 100^0C 100 ℃and that of surrounding is 20 ℃ 20^0C if water cools down to 60 ℃ 60^0C in first 20 minutes. During what time will it cool to 30^0C ?
13. Temperature of water initially is 100^0C 100 ℃and that of surrounding is 20 ℃ 25^0C if water cools down to 60 ℃ 80^0C in first 10 minutes. During what time will it cool to 60^0C ?30 ℃ ?
14. According to Newton's law of cooling the rate at which substance cools in moving air is proportional to the difference between the temperature of the substance and that of the air. If temperature of air is 30^0C 30 ℃ and the substance cools from 37^0C 37℃ to 34^0C 34 ℃ in 15 minutes, find when the temperature will be 31^0C 31℃. 15 .
15. If a thermometer is taken outdoors where the temperature is 0^0C 0 ℃, from a room in which the temperature is 21^0C 21 ℃ and reading drops to 10^0C 10 ℃ in 1 minute. How long after its removal will the reading be 5^0C ?

D. **SIMPLE ELECTRIC CIRCUITS:-**

1. A constant electromotive force E volts is applied to a circuit containing a constant resistance R ohms in series and a constant inductance L henries. If the initial current is zero , show that the current build-up to half its theoretical maximum in $\frac{Lloglog\,2}{R}$ seconds.
2. A circuit consist of resistance R ohms and a condenser of c farads connected to a constant e.m.f. E. If $\frac{q}{c}$ is voltage of the condenser at a time t after closing the circuit. Show that the voltage at time t is $\frac{q}{c} = E\left(1 - e^{\frac{-t}{CR}}\right)$.
3. An electric circuit contains an inductance of 0.5 henries and a resistance of 100 ohms in a series with an e.m.f. of 20 volts . find the current at any time t,it is zero at $t = 0$.
4. An e.m.f of $200e^{-5t}$ is applied to a circuit consisting 20Ω resister and 0.01F capacitor. find the charge and current at any time , assuming that there is no initial charge on capacitor.
5. In the circuit containing inductance L, resistance R and voltage E, the current I is given by : $E = RI + L\frac{dI}{dt}$, Given : L=640H ,$R = 250\Omega$ E=200 volts. I being zero when t=0.Find the time that elapses before it reaches 80% of its maximum value.
6. An e.m.f. $200e^{-5t}$ is applied to a series circuit containing of 20 ohms resistor and 0.01 F capacitor. Find the charge and current at any assuming that there is no initial charge on the capacitor.
7. In the circuit containing inductance L=640 H , resistance R=250 Ω are connected in series with battery of E=500 volts. Find the current in the circuit if i =0 when t=0
8. A resistance of 100Ω ,an inductance 0.5 henary are connected in series with a battery of 20 volts. find the current in a circuit as a function of t, if i=0 at t=0.
9. Find current i in a circuit having resistance R and condenser of capacity C in series with emf $E\ sin\ sin\ \omega t$.
10. The equation L-R circuit given by $L\frac{dI}{dt} + RI = 10sint$. If $I = 0$, at $t = 0$ express I as function of t .
11. An e.m.f. $200e^{-5t}$ $200\ e^{-5t}$ is applied to a series circuit consisting of 20 Ω resistor and 0.01 F capacitor. Find the charge and the current at any time, assuming that there is no initial

12. The charge Q on the plate of a condenser of capacity $'C'$ charged through a resistance $'R'$ by steady voltage $'V'$ satisfies the differential equation $R\frac{dQ}{dt}+\frac{Q}{C}=V$. If $Q=0$ at $t=0$ then show that $Q=CV\left[1-e^{-t/RC}\right]$. Find the current flowing into the plate.
13. A capacitor $C=0.01\ F$ in series with a resistor $r=20\Omega$ is charged from a battery 10 volts. Assuming that initially the capacitor is completely uncharged, determine the charge $Q(t)$ and current $I(t)$.

E. <u>RECTILINEAR MOTION :-</u>

1. A particle is moving in a straight line with an acceleration $k\left[x+\frac{a^4}{x^3}\right]$ directed towards origin. If it stars from rest at a distance ' a' from origin , prove that it will arrive at origin at the end of time $\frac{\pi}{4\sqrt{k}}$.
2. The x descended by a parachuter satisfies the differential equation, $v\frac{dv}{dx}=g\left(1-\frac{v^2}{k^2}\right)$,where v is velocity ,k ,g are constants. If $v=0$ and $x=0$ at time $t=0$ show that $=\frac{k^2}{g}logcosh\left(\frac{gt}{k}\right)$.
3. A bullet is fired into sand tank ,its retardation is proportional to square root of its velocity. show that the bullet will come to rest in time $\frac{2\sqrt{v}}{k}$, where V is initial velocity.
4. A body starts moving from rest is opposed by a force per unit mass of value cx and resistance per unit mass of the value bv^2, where x and v are the displacement and velocity of that body at that body at that instant.show that the velocity of the body is given by :$v^2=\frac{c}{2b^2}(1-e^{-2bx})-\frac{cx}{b}$
5. A body of mass m falling from rest is subjected to the force of gravity and an air resistance proportional to the square of the velocity (kv^2). If it falls through distance ' x' and possesses a velocity 'v' at that instant , prove that $\frac{2kx}{m}=log\left(\frac{a^2}{a^2-v^2}\right)$, where $mg=Ka^2$.
6. A body of mass falls from rest under gravity in a fluid whose resistance to motion at any instant is mK time its velocity , where K is constant .Find the terminal velocity of the body and also the time taken to acquire one-half of its limiting speed.
7. The x descended by a parachuter satisfies the differential equation $\left(\frac{dx}{dt}\right)^2=k^2\left(1-e^{\frac{-2gx}{k^2}}\right)$ where 'k' and 'g' are constants and x=0 when t=0 .show that $x=\frac{k^2}{g}logcosh\left(\frac{gt}{k}\right)$.
8. A body of mass 'm' falls from rest under influence of gravity and a retarding force due to air resistance proportional to square of velocity . Find the velocity and distance described as a function of time. Hence, show that the velocity of the body approaches the limiting value.

9. A particle of unit mass moves in a horizontal straight line OA with an acceleration $\frac{k}{r^3}$ at a distance r and directed towards 0.If initially the particle was at rest at a distance a from 0,show that it will be a distance $\frac{a}{2}$ from 0 at the end of time $\frac{a^2}{2}\sqrt{\frac{3}{k}}$.
10. Assuming that the resistance to movement of a ship through water in the form of $(a^2 + b^2\, v^2)$, where v is the velocity, a and b are constants, write down the differential equation for retardation of ship moving with engine stopped. Prove that the time in which the speed falls to one half its original value u is given by $\frac{w}{abg}\left(\frac{abu}{2a^2+b^2u^2}\right)$, where w is the length of the ship.
11. A particle of mass m is projected vertically upward with velocity V_0. Assuming that the air resistance is k times the velocity, show that the particle will reach maximum height in time $\frac{m}{k} log\left(1+\frac{kv_0}{mg}\right)$.

A. REDUCTION FORMULAE:-

1. $If\ I_n = \int_0^{\infty} e^{-x} sin^n x\ dx\ obtain\ the\ relation\ between\ I_n\ and\ I_{n-2}.$
2. $If\ U_n = \int_0^{\frac{\pi}{2}} \theta\ cos^n\theta\ d\theta\ then\ show\ that\ U_n = \frac{1}{n^2} + \frac{(n-1)}{n} U_{n-2},\ hence\ evaluate\ U_4.$
3. $If\ I_n = \int_0^{\frac{\pi}{4}} cos^{2n}\ x\ dx,\ prove\ that\ I_n = \frac{1}{n2^{n+1}} + \frac{2n-1}{2n}\ I_{n-1}.$
4. $If\ U_n = \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} cot^n\theta\ d\theta\ prove\ that\ I_n = \frac{1}{n-1} - I_{n-2},Hence\ evaluate\ I_3.$
5. $If\ I_n = \int_0^{\frac{\pi}{2}} x^n cosx\ dx\ prove\ that\ I_n = \left(\frac{\pi}{2}\right)^n - n(n-1)I_{n-2}.$
6. $If\ I_n = \int_0^{\infty} e^{-x} sin^n x\ dx\ \ obtain\ the\ relation\ between\ I_n\ \ and\ I_{n-2}.$
7. If $u_n = \int_0^{\pi/4} \theta\ d\theta$ then show that $n(u_{n+1} + u_{n-1}) = 1.$
8. $If\ I_n = \int_0^{\frac{\pi}{4}} sec^n\theta\ d\theta\ ,prove\ that\ I_n = \frac{(\sqrt{2})^{n-2}}{n-1} + \frac{n-2}{n-1} I_{n-2}.$
9. $Find\ reduction\ formula\ for\ \int_0^{\frac{\pi}{3}} cos^n x\ dx.$

B. GAMMA FUCTION:-

Progressive Education Society's

Modern College of Engineering , Shivajinagar, Pune-05.

Engineering Mathematics-II (Academic year: 2019-20)

Unit - III : Integral Calculus:(Reduction Formulae, Gamma & Beta function , DUIS & Error function)

1. $Evaluate: \int_0^1 (x log x)^4\, dx$.
2. $Evaluate \int_0^\infty \sqrt[4]{x}\, e^{-\sqrt{x}}\, dx$
3. $Evaluate \int_0^\infty \frac{x^3}{3^x} dx.$
4. Evaluate $\int_0^\infty x^7 e^{-2x^2} dx$
5. $Evaluate \int_0^\infty \frac{x^4}{4^x}\, dx.$
6. $Evaluate \int_0^\infty \sqrt{y}\, e^{-\sqrt{y}}\, dy$
7. $Evaluate \int_0^\infty \frac{dx}{3^{4x^2}}$

C. BETA FUCTION:-

1. $Evaluate \int_0^\pi x sin^5 x cos^2 x dx$.
2. $Evaluate \int_0^1 x^m (1-x^n)^p dx$.
3. $Evaluate \int_2^5 (x-2)^3 (5-x)^2\, dx.$
4. $Evaluate \int_0^\infty \frac{x^8 - x^{14}}{(1+x)^{24}}\, dx$.
5. $Evaluate \int_3^5 (x-3)^{\frac{1}{2}} (5-x)^{\frac{1}{2}} dx.$
6. $Evaluate \int_0^\infty \frac{dx}{1+x^4}$.
7. $Evaluate \int_0^{2a} x\sqrt{2ax - x^2}\, dx.$
8. $Evaluate \int_0^{2a} x^{\frac{7}{2}} (2ax - x^2)^{-\frac{1}{2}} dx$
9. $Evaluate \int_0^\infty \frac{x^9(1-x^5)}{(1+x)^{25}}$

D. DIFFERENTIATION UNDER INTEGRAL SIGN

1. $Using\ differentiation\ under\ integral\ sign\ prove\ that \int_0^\infty \frac{e^{-x} - e^{-ax}}{x sec\, x}\, dx = \frac{1}{2} log\, log \left(\frac{a^2+1}{2}\right), a > 0.$
2. $Prove\ that\ \phi(a) = \int_{\pi/6a}^{\pi/2a} \frac{sin sin\, ax}{x} dx\ is\ independent\ of\ a.$
3. $If\ f(x) = \int_2^x (x-t) G(t) dt\ then\ prove\ that \frac{d^2 f}{dx^2} - G(x) = 0$
4. $If\ f(x) = \int_a^x (x-t)^2 G(t) dt\ then\ prove\ that \frac{d^3 f}{dx^3} - 2G(x) = 0$
5. $Show\ that \int_0^\infty \frac{ax}{x(1+x^2)}\, dx = \frac{\pi}{2} log\, log\, (1+a)$
6. $Show\ that \int_0^1 \frac{x^a - x^b}{log log\, x} dx = log\, log \left(\frac{a+1}{b+1}\right),\ a > 0, b > 0.$
7. $Show\ that \int_0^1 \frac{e^{-ax} - e^{-bx}}{x} dx = log\, log \left(\frac{b}{a}\right),\ a > 0, b > 0.$
8. $Evaluate \int_0^\infty e^{-ax} \frac{sin sin\, x}{x}\, dx$.
9. $Evaluate \int_0^\infty \frac{e^{-x} sin sin\, ax}{x}\, dx.$

10. $Evaluate\ \int_0^1 \frac{x^m-1}{loglog\ x}\ dx$.
11. $If\ \phi(a) = \int_a^{a^2} \frac{sinsin\ ax}{x}\ dx, find\ \frac{d\phi}{dx}$

E. ERROR FUNCTIONS

1. $Show\ that\ \int_0^\infty e^{-x^2-2bx}\ dx = \frac{\sqrt{\pi}}{2}\ e^{b^2}[1-(b)\ ].$
2. $Show\ that\ \int_a^b e^{-x^2} dx = \frac{\sqrt{\pi}}{2}\{(b)-erf(a)\ \}.$
3. $If\ \alpha(x) = \sqrt{\frac{2}{\pi}}\int_0^x e^{-\frac{t^2}{2}} dt, show\ that\ (x)\ = \alpha[x\sqrt{2}]$
4. $Define\ erfc(ax)\ , find\ \frac{d}{dx} erfc(ax)$
5. $Evaluate\ \int_o^t (4x)\ dx\ + \int_0^t erfc(4x)dx.$
6. $Prove\ that\ \frac{d}{dt} erf(\sqrt{t}) = \frac{e^{-t}}{\sqrt{\pi t}}.$
7. $Prove\ that\ (x)\ + (-x)\ = 2.$
8. $Prove\ that\ \frac{d}{dx}[(ax^n)\ ] = \frac{2an}{\sqrt{\pi}} x^{n-1} e^{-a^2} x^{2n}.$
9. $Prove\ that\ \int_0^\infty e^{-x^2-2bx}\ dx = \frac{\sqrt{\pi}}{2}\ e^{b^2} erfc\ (b).$

A. RECTIFICATION

1. $Find\ the\ arc\ length\ of\ the\ curve\ (using\ rectification)\ r = 2a\ cos\ cos\ \theta$
2. $Find\ the\ length\ of\ the\ curve\ x = a(\theta - sin\ sin\ \theta\ ), y = a(1 - cos\ cos\ \theta)\ \ between\ \theta = 0\ and\ \theta = 2\pi.$
3. $Find\ the\ length\ of\ the\ arc\ of\ cardioid\ r = a(1 - cos\ \theta)\ which\ lies\ outside\ the\ circle\ r = \theta\ .$
4. $Find\ the\ arc\ length\ of\ \ one\ loop\ of\ lemniscate\ r^2 = a^2\ cos\ cos\ 2\theta\ .$
5. $Find\ the\ arc\ length\ of\ upper\ half\ of\ one\ loop\ of\ lemniscate\ r^2 = a^2\ cos\ cos\ 2\theta\ .$
6. $Find\ the\ perimeter\ of\ cardioid\ r = a(1 + cos\ cos\ \theta)$
7. $Show\ that\ length\ of\ an\ arc\ of\ \ curve\ x = log\ log\ (sec\theta + tan\ tan\ \theta) - sin\ sin\ \theta,\quad y = cos\ cos\ \theta\ \ from\ \theta = 0\ to$

   $\theta = t\ is\ log\ (sec\ t).$
8. $Find\ the\ length\ of\ arc\ of\ an\ asteroid\ x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$

9. *Find the length of the cardioids* $r = a(1 + cos\ cos\ \theta)$ *which lies outside the circle* $r + \theta = 0$
10. *Find the arc length of the curve* $x = e^{\theta}\ cos\ cos\ \theta,\ y = e^{\theta}\ sin\ sin\ \theta$ *from* $\theta = 0$ *to* $\theta = \frac{\pi}{2}$.
11. Find the perimeter of the cardioid $r = a(1 + cos\ cos\ \theta)$ from $\theta = 0$ to $\theta = \frac{\pi}{3}$.

B. TRACE THE CURVE :

Cartesian Curves:

1. $y^2 = x^2(1 - x)$.
2. $xy^2 = a^2(a - x)$
3. $y^2(a^2 - x^2) = a^3x$
4. $y^2(a + x) = x^2(a - x)$
5. $x^2y^2 = a^2(y^2 - x^2)$
6. $y^2 = x^5(2a - x)$
7. $ay^2 = x^2(a - x)$
8. $y^2(2a - x) = x^3$

Polar Curves:

1. $r = 2\ sin\ sin\ 3\theta$
2. $r = 2\theta$
3. $r = 3\theta$
4. $r^2 = a^2\ cos\ cos\ 2\theta$
5. $r = 3\theta$
6. $r = 2\theta$
7. $r = a(1 + sin\ sin\ \theta)$
8. $r = a(1 + cos\ cos\ \theta)$
9. $r = a(1 - sin\ sin\ \theta)$
10. $r = a(1 - cos\ cos\ \theta)$
11. $r = a(1 + 2cos\theta)$
12. $r(1 + sin\theta) = 2a$
13. $r = a + b\ cos\theta,\ for\ a > b\ , a < b\ , a = b$

Parametric Curves:

1. $x = a(t + sin\ sin\ t), y = a(1 - cos\ cos\ t)$
2. $x = a(t + sin\ sin\ t), y = a(1 + cos\ cos\ t)$
3. $x = a(t - sin\ sin\ t), y = a(1 - cos\ cos\ t)$
4. $x = a(t - sin\ sin\ t), y = a(1 + cos\ cos\ t)$
5. $x^{2/3} + y^{2/3} = a^{2/3}$.
6. $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} = 1$.

SPHERE

1. Find the equation of sphere, having its centre on the plane $4x - 5y - z = 3$ and passing through the circle, $x^2 + y^2 + z^2 - 2x - 3y + 4z + 8 = 0, x - 2y + z = 8$.
2. Find the equation of the sphere which is tangential to the plane $4x - 3y + 6z - 35 = 0$ at (2,-1,4) and passing through the point $(2, -1, -2)$.
3. Prove that two spheres $x^2 + y^2 + z^2 - 2x + 4y - 4z = 0$ and $x^2 + y^2 + z^2 + 10x + 2z + 10 = 0$ touch each other and hence find the coordinates of the point of contact.
4. Show that the plane $2x - 2y + z + 12 = 0$ touches the sphere $x^2 + y^2 + z^2 - 2x - 4y + 2z - 3 = 0$ and find the point of contact.

5. Find the equation of the sphere which passes through the points $(1,-4,3),(1,-5,2),(1,-3,0)$ and whose centre lies on the plane $x+y+z=0$.
6. A sphere of constant radius passes through the origin and meets the axes in A, B< C. prove that the centroid of the sphere $9(x^2+y^2+z^2)=4K^2$
7. Find the equation of the sphere which passes through the point (3,1,2) and meets X and Y plane in a circle of radius 3 units with centre at (1,-2,0) .
8. Find the equation of the sphere passing through the circle $x^2+y^2+z^2=9$,$2x+3y+4z=5$ and the point (1,2,3).
9. Show that the plane $4x-3y+6z-35=0$ is tangential to the sphere $x^2+y^2+z^2-y-2z-14=0$ and find the point of contact.
10. Find the equation at the sphere through the circle $x^2+y^2+z^2=1, 2x+3y+4z=5$ and which intersects the sphere $x^2+y^2+z^2+3(x-y+z)-56=0$ and orthogonally.
11. Find the equation at the sphere through the circle $x^2+y^2+z^2=4, z=0$ and cutting the sphere $x^2+y^2+z^2+10y-4z-8=0$ orthogonally
12. A sphere S has points (1,-2,3) and (4,0,6) as opposite ends of a diameter .find the equation of the sphere having the intersection of S with the plane $x-y-2z+6=0$ as its great circle.
13. Find the equation of the sphere tangential to the plane $x-2y-2z=7$ at (3,-1,-1) and passing through the point(1,1,-3).
14. Find the center and radius of the circle which is an intersection of the sphere $x^2+y^2+z^2-2y-4z-11=0$ by the plane $x+2y+2z=15$.
15. Find the equation of the sphere through the circle $x^2+y^2+z^2=9; z=0$ and the point (α,β,γ).
16. Find the center & radius of the circle which is an intersection of the sphere $x^2+y^2+z^2-2x+4y+2z-6=0$ by the plane $x+2y+2z-4=0$.
17. Find the equation of sphere which touches the coordinate axes, whose centre is in positive octant and has radius 4.
18. Find the equation of sphere which has its centre at (2, 3, -1) and touches the line: $\frac{x+1}{-5}=\frac{y-8}{3}=\frac{z-4}{4}$.
19. Find equation of sphere for which the circle $x^2+y^2+z^2+7y-2z+2=0, 2x+3y+4z=8$ is a great circle.
20. Find the equation of sphere through the circle $x^2+y^2+z^2=4, z=0$ meeting the plane $x+2y+2z=0$ in a circle of radius 3.
21. Show that the two spheres $x^2+y^2+z^2=25$ and $x^2+y^2+z^2-18x-24y-40z+225=0$ touches externally and find their point of contact.

CONE

1. Find equation of a right circular cone , having vertex at point $(0,0,3)$ passing through the circle $x^2+y^2=16, z=0$.
2. Find the equation of right circular cone with vertex at origin, whose axis is the line $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$, and which has a semi vertical angle of 30°.
3. Find equation of right circular cone with vertex at $(1,2-3)$, semi vertical angle $\left(\frac{1}{\sqrt{3}}\right)$ and line $\frac{x-1}{1}=\frac{y-2}{2}=\frac{z+3}{-1}$.
4. Find the equation of right circular cone which passes through the point $(2,1,3)$ with vertex at $(1,1,2)$ and axis parallel to the line $\frac{x-2}{2}=\frac{y-1}{-4}=\frac{z+2}{3}$.

5. Find the equation of right circular cone which passes through the point $(2,-2,\ 1)$ with vertex at origin and axis parallel to the line $\frac{x-2}{5}=\frac{y-1}{1}=\frac{z+2}{1}$.
6. Lines are drawn from the origin with direction cosines proportional to $(1,2,2),(2,3,6),(3,4,12)$. Find direction cosines of the axis of right circular cone through them, and prove that the semi vertical angle of cone is $\left(\frac{1}{\sqrt{3}}\right)$.
7. Find the equation of the right circular cone which has its vertex at the point $(0,0,10)$ and whose intersection with the plane XOY is a circle of diameter 10.
8. Find the equation of the right circular cone which has its vertex at the point $(0,0,10)$ and whose intersection with the XOY-plane is a circle of diameter 5.
9. Find the equation of cone which has vertex at origin , axis is the y –axis and semi vertical angle is 30°
10. Find equation of right circular cone whose vertex is at origin with axis $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$ and has a semi-vertical angle 30°.
11. Find the equation of right circular cone whose vertex is (1,2,3) and the axis has direction ratios (2,-1,4) and semi-vertical angle is 60°.
12. Find the equation of right circular cone whose vertex is (0,0,2) and the axis has direction ratios (0,3,-2) axis is Z -axis.
13. Find the equation of the right circular cone whose vertex is (1,-1,1) and axis is parallel to $\frac{x}{1}=\frac{-y}{2}=\frac{-z}{1}$ and one of its generators has direction cosines proportional to (2,2,1).
14. Find the equation of the right circular cone whose vertex is given by (1,-1,2) and axis is the lone $\frac{x-1}{2}=\frac{y+1}{1}=\frac{z-2}{-2}$ and semi-vertical angle is 45°.
15. Find the equation of right circular cone with vertex at o (1,1,1), whose axis is the line $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z-1}{3}$, and which has a semi vertical angle of $\frac{\pi}{4}$.
16. Find the equation of right circular cone with vertex (-1, 0, 0), semi vertical angle $60^{\circ}$and axis is x –axis.
17. Find the equation of the right circular cone with vertex at origin making equal angles with the co-ordinate axes and having generator with direction cosines proportional to 1,-2,2.
18. Find the equation of the right circular cone which passes through the point (1,1,2) has its axis at the line $6x=-3y=4z$ and vertex at origin.
19. Find the equation of the right circular cone whose vertex is at (0,0,0) , semivertical angle $\frac{\pi}{4}$ and axis along the line
$x=-2y=z$
20. Find the equation of right circular cone whose vertex is (1,2,3) and the axis is given by $\frac{x-1}{2}=\frac{y-2}{-1}=\frac{z-3}{3}$ and semi-vertical angle is 60°.

CYLINDER

1. Find the equation of a right circular cylinder of radius 2, whose axis passes through the point $(1,1,-2)$ and has direction cosines proportional to $(2,1,2)$.
2. Find the equation of right circular cylinder whose axis is $\frac{x-1}{2}=\frac{y-2}{1}=\frac{z-3}{2}$ and radius 2.

3. Find the equation of right circular cylinder of radius 3 and axis is $\frac{x-1}{1}=\frac{y+1}{-1}=\frac{z-2}{3}$.
4. Find the equation of right circular cylinder of radius a axis passes through the origin and makes equal angles with the coordinate axes.
5. Find the equation of the right circular cylinder of radius 3 and axis $\frac{x-1}{2}=\frac{y-3}{2}=\frac{z-5}{-1}$.
6. Find the equation of right circular cylinder of radius 2 whose axis passes through (1,2,3) and has direction cosines proportional to (2,1,2).
7. Find the equation of the right circular cylinder of radius 4 with axis passing through origin and making angles with the co-ordinates axes.
8. Find the equation of the right circular cylinder of radius 2 and axis is given by $\frac{x-1}{2}=\frac{y-2}{-3}=\frac{z-3}{6}$
9. Find the equation of the right circular cylinder of radius 2 and axis is given by $\frac{x-1}{2}=\frac{y}{3}=\frac{z-3}{1}$
10. Find the equation of the right circular cylinder of radius 4 and axis is given by $\frac{x+1}{1}=\frac{y+1}{-1}=\frac{z+1}{1}$
11. Obtain the equation of the right circular cylinder of radius 5 where axis is : $\frac{x-2}{3}=\frac{y-3}{1}=\frac{z+1}{1}$
12. Find the equation of the right circular cylinder whose axis is $\frac{x-2}{2}=\frac{y-1}{1}=\frac{z}{3}$ and which passes through the point (0,0,3).
13. Find the equation of right circular cylinder of radius 2 whose axis passes through (1,2,3) and has direction cosines proportional to (2,-3,6).
14. Find the equation of the right circular cylinder whose guiding curve is $x^2+y^2+z^2=9, x+y+z=3$.
15. Find the equation of right circular cylinder whose axis is $x=2y=-z$ and radius is 4.

DOUBLE INTEGRATION

Evaluate :

1. $\int_0^a \int_{\frac{y^2}{a}}^{y} \frac{y\,dx\,dy}{(a-x)\sqrt{ax-y^2}}$
2. $\int_0^{\frac{\pi}{2}} \int_0^{y} cos\ cos\ 2y\sqrt{1-a^2x}\ \ dxdy$
3. $\int_0^1 dx \int_1^{\infty} e^{-y}\,y^x\,log\,log\,y\,dy$
4. $\int_0^a \int_0^{\sqrt{a^2-x^2}} sin\left\{\frac{\pi}{a^2}(a^2-x^2-y^2)\right\}\,dx\,dy$
5. $\int_0^{a/\sqrt{2}} \int_y^{\sqrt{a^2-y^2}} log_e(x^2+y^2)\,dx\,dy$
6. $\int_0^1 \int_0^{\sqrt{1-y^2}} \frac{x\,dx\,dy}{\sqrt{(1-x^2-y^2)(1-x^2)}}$
7. $\int_0^a \int_0^{\sqrt{a^2-x^2}} e^{-x^2-y^2}\,dxdy$

8. $\int_0^1 \int_0^{\sqrt{1-x^2}} \frac{dx\,dy}{(1+x^2+y^2)}$
9. $\int_0^1 \int_0^{\sqrt{1-x^2}} \frac{y\,dy\,dx}{(1+y^2)\sqrt{(1-x^2-y^2)}}$
10. $\iint (x+y)^2\,dx\,dy$ *over the area bounded by an ellipse* $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$
11. $\iint_R sin\ sin\ (x^2+y^2)dx\,dy$ *, where R is circle* $x^2+y^2=a^2$
12. $\iint_R \frac{1}{x^4+y^2}\,dx\,dy$ *, over the region* $y \geq x^2, x \geq 1$
13. $\iint_R \frac{x^2\,y^2\,dx\,dy}{x^2+\,y^2}$ *, where R is annulus between* $x^2+y^2=4$ *and* $x^2+y^2=9$
14. *Change Order of the integration and Evaluate* $\int_0^\infty \int_x^\infty \frac{e^{-y}}{y}\,dx\,dy$.
15. *Evaluate by changing order of the integration* $\int_0^\infty \int_0^x x\,e^{-\frac{x^2}{y}}\,dx\,dy$
16. *Change order of the integration* $\int_0^5 \int_{2-x}^{2+x} f\,(x\,,y\,)\,dx\,dy$
17. *Change order of the integration* $\int_0^a \int_{\sqrt{a^2-y^2}}^{y+a} f\,(x\,,y\,)\,dx\,dy$
18. $\iint_R x^2\,y^2\,dx\,dy$ *, over the positive quadrant of* $x^2+y^2=1$.

TRIPLE INTEGRATION :

Evaluate :

1. $\int_0^\infty \int_0^\infty \int_0^\infty \frac{dx\,dy\,dz}{(1+x^2+y^2+z^2)^2}$
2. $\int_{-1}^1 \int_0^z \int_{x-z}^{x+z} (x+y+z)\,dx\,dy\,dz$
3. $\int_0^2 \int_0^x \int_0^{2x+2y} e^{x+y+z}dx\,dy\,dz$
4. $\int_0^{log\,log\,2} \int_0^x \int_0^{x+y} e^{x+y+z}dx\,dy$

5. $Evaluate \iiint \sqrt{x^2+y^2}dx\,dy\,dz$, $where\ V\ is\ bounded\ by\ the\ surface\ x^2+y^2=z^2, z\geq 0$, $plane\ z=1.$
6. $Evaluate \iiint \frac{dx\,dy\,dz}{\sqrt{1-x^2-y^2-z^2}}$, $where\ V\ is\ volume\ of\ sphere\ x^2+y^2+z^2=1$
7. $Evaluate \iiint z(x^2+y^2)dx\,dy\,dz$, $over\ volume\ of\ cylinder\ x^2+y^2=1\ intercepted\ by\ planes\ z=2\ \&\ z=3$
8. $Evaluate \iiint (x^2y^2+y^2z^2+z^2x^2)dx\,dy\,dz$, $throughout\ volume\ of\ the\ sphere\ x^2+y^2+z^2=a^2$
9. $Evaluate \iiint \frac{dx\,dy\,dz}{\sqrt{a^2-x^2-y^2-z^2}}$, $throughout\ volume\ of\ the\ sphere\ x^2+y^2+z^2=a^2\ in\ the\ positive\ octant.$
10. $Evaluate \iiint \frac{dx\,dy\,dz}{\sqrt{1-\frac{x^2}{a^2}-\frac{y^2}{b^2}-\frac{z^2}{c^2}}}$, $throughout\ volume\ of\ the\ ellipsoid\ \frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1.$
11. $Evaluate \iiint \sqrt{x^2+y^2}dx\,dy\,dz$, $V\ is\ volume\ of\ cone\ x^2+y^2=z^2, z>0\ bounded\ by\ plane\ z=0\ \&\ z=1.$

Moment of Inertia :

1. Find Moment of Inertia (M.I.) About the line $\theta=\frac{\pi}{2}$ of the area enclosed by the curve $r=a(1+cos\,cos\,\theta)$.
2. Find Moment of Inertia of circular lamina $x^2+y^2=2ax$ about an axis passing through origin and perpendicular to the plane of the curve . The density of a circular lamina varies as the square of the distance of the point from the origin .
3. Find Moment of Inertia (M.I.) about the initial line of the cardioid $r=a(1+cos\,cos\,\theta)$.
4. Find Moment of Inertia about the X-axis of the area enclosed by the lines $x=0$, $y=0$, $\frac{x}{a}+\frac{y}{b}=1.$
5. Find Moment of Inertia of one loop of lemniscate $r^2=\theta$ about initial line.
6. Find Moment of Inertia of the portion of the parabola $y^2=4ax$ bounded by x-axis and latus recum,about x-axis,if density at each point varies as the cube of the abscissa.
7. Find moment of inertia of the circular plate $r=2a\,cos\theta$ about the line $\theta=\frac{\pi}{2}$.
8. Prove that Moment of Inertia included between the curves $y^2=4ax$ and $x^2=4ay$ about x axis is $\frac{144}{35}Ma^2$, where M is mass of the area included between the curves.
9. Find Moment of Inertia of a sphere about a diameter.
10. A rod of length l is divided into two parts at random. Find average of sum of squares of these parts. Also find mean value of rectangle contained by these two segments.

Centre of Gravity :

1. Find the centre of Gravity (C.G.)/centroid of one loop of the curve $r=2\theta$.
2. Find the centroid of the loop of the curve $r^2=\theta$.

3. Find the X-coordinates of Centre of Gravity of an area bounded by the parabola $y^2 = x$ and the line $x + y = 2$
4. Find C.G. of one loop of curve : $y^2(a + x) = x^2(a - x)$.
5. Find the centre of Gravity (C.G.) of an area of cardioid $r = \theta$) .
6. Find C. G. of an arc of the Catenary : $y = a\ cosh\left(\frac{x}{a}\right)$ from $x = -a\ to\ x = a$.
7. ABCD is a square plate of side a and 0 is the mid-point of AB. If the surface density varies as the square of distance from 0, show that the center of gravity of the plate is at a distance $\frac{7a}{10}$ from 0.

AREA :

1. Find by double integration the area between the curve $y^2x = 4a^2(2a - x)$ and its asymptote.
2. Find the area enclosed by the curve $a^2x^2 = y^3(2a - y)$
3. Find the area bounded by parabola $y = x^2$ and the line $y = 2x + 3$.
4. Find the area bounded by parabola $y = x^2$ and the line $y = x$
5. Find the total area included between the two cardioids $r = a\ (1 + cos\ cos\ \theta)$ & $r = a\ (1 - cos\ cos\ \theta)$.
6. Find the area bounded by parabola $y^2 = 4x$ and the line $2x - 3y + 4 = 0$.
7. Find the area inside the circle $= \theta$. and outside the cardioide $r = \theta$) .
8. Find total area of the Astroid $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$.
9. Find area of upper half of the cardioid $r = a\ (1 + cos\theta)$

VOLUME :

1. Find the volume of cylinder $x^2 + y^2 = 2ax$ intercepted between paraboloid $x^2 + y^2 = 2az$ and XOY plane.
2. Find the volume of the region bounded by the paraboloid $x^2 + y^2 = 2z$ and the cylinder $x^2 + y^2 = 4$.
3. Find the volume of the region bounded by the paraboloid $x^2 + y^2 = 4z$ cutoff by the plane z=4.
4. Find the Volume of Tetrahedron bounded by the coordinate planes and the plane $x + y + z = 1$
5. Find the Volume of Tetrahedron bounded by the coordinate planes and the plane $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$
6. Find the volume common to the cylinders : $x^2 + y^2 = a^2$ and $x^2 + z^2 = a^2$.
7. Find the volume of the region enclosed by the cone $z = \sqrt{x^2 + y^2}$ and paraboloid $z = x^2 + y^2$.
8. Find the volume cut off from the paraboloid $x^2 + \frac{y^2}{4} + z = 1$ by the plane $z = 0$.
9. Find volume of solid common to the cylinders $x^2 + y^2 = a^2\ and\ x^2 + z^2 = a^2$.
10. Find the Volume of Tetrahedron bounded by the coordinate planes and the plane $\frac{x}{2} + \frac{y}{3} + \frac{z}{4} = 1$