Course Information

B Tech I & II Semesters (2019-20)

Compiled by

DEPARTMENT OF SCIENCE & HUMANITIES

PES UNIVERSITY

Preamble

This book contains the detailed lesson plan structure for all the subjects in the first and second semesters. This gives the student a fair idea of what happens in the class on any particular day.

The book also contains a bank of questions which is a compilation of questions from the past question papers and question types with varying levels of difficulty. This would be helpful for the student to practice himself / herself on a day to day basis.

This book is intended to ensure that the student practices a minimum number of problems in each topic to make him / her proficient in the topics.

SCHEME FOR B Tech
I & II SEMESTER
(AUGUST 2019 – MAY 2020)
COMMON TO ALL BRANCHES

Index

UE19MA101: ENGINEERING MATHEMATICS-I (3-1-1-0-4)

LESSON PLAN

Class	Title Reference	Portions to be covered	Percentage Covered/ Marks allotted
1-3	**UNIT-I DIFFERENTIAL CALCULUS**	Polar curves, angle between radius vector and tangent, angle between two curves.	20% 20 Marks
4(L-1)		Introduction to Maxima, angle between radius vector and tangent, angle between two curves.	
5		Pedal equation – problems	
6-8		Radius of curvature in Cartesian, polar, parametric and pedal forms – problems.	
9		Taylor's Theorem (Generalised Mean Value Theorem)	
10(L-2)		Maxima commands to find the derivative,nth derivatives andRadius of curvature.	
11		Taylor's and Maclaurin's series expansions (one variable), Application problems.	
12	**UNIT-II PARTIAL DIFFERENTIATION**	Introduction to partial differentiation and its Geometrical interpretation.	40% 20 Marks
13-14		Definition of homogeneous functions, Euler's theorem – problems.	
15-16		Total differentiation, derivative of implicit and composite functions, chain rule.	
17(L-3)		Maxima commands to find partial derivatives, verifying Euler's theorem.	
18		Lagrange's Method of undetermined multipliers.	
19		Maxima & Minima for function of two variables. Errors and approximations-problems, Application problems.	
20(L-4)		Maxima commands for Taylor's and Maclaurin's series.	
21-22	**UNIT-III INTEGRAL CALCULUS**	Introduction to Jacobians, Properties of Jacobians.	60% 20 Marks
23		Introduction to double integrals – problems.	
24(L-5)		Maxima commands for finding Jacobians, multiple integrals.	
25		Evaluation of double integrals by changing the order of integration.	
26		Evaluation of double integrals by changing the variables.	
27		Introduction to triple integrals.	
28(L-6)		Maxima commands for Tracing of curves.	
29-30		Evaluation of triple integral by changing the variables(Spherical & Cylindrical).	
31-33		Applications of Multiple integrals- Centre of Mass & Moment of inertia.	
34-35	**UNIT- IV ORDINRY DIFFERENTIAL EQUATIONS**	Linear and reducible to linear (Bernoulli's differential equations).	80% 20 Marks
36-37		Exact and Reducible to exact differential equations.	
38(L-7)		Maxima Commands to solve ordinary differential equations and to plot their solutions.	

39		Orthogonal trajectories - Cartesian and polar form.	
40-42		Solution of First order nonlinear differential equations, Application problems on differential equations (Newton's law of cooling).	
43(L-8)		Maxima commands to plot orthogonal trajectories.	
44	**UNIT V HIGHER ORDER DIFFERENTIAL EQUATIONS**	Introduction to higher order differential equations, complimentary function and particular integral.	100% 20 Marks
45-46		Particular integral and general solution for standard functions.	
47		Cauchy's and Legendre's differential equations.	
48(L-9)		Maxima commands to solve higher order differential Equations.	
49		Solution of differential equation by the method of Variation of parameters.	
50		Applications problems on differential equations(Vibration of a beam).	
51		Series solution of differential equations.	
52(L-10)		LAB TEST	
53-56		Revision classes	

Reference books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, 10th Edition, 2015.
2. Higher Engineering Mathematics by B.S.Grewal, Khanna Publishers, 44th edition, 2017.
3. Higher Engineering Mathematics by B V Ramana. Tata McGraw-Hill Education, 23rdprint ,2015.
4. Calculus -James Stewart 8th edition, Cengage publications.

QUESTION BANK

UNIT – I

DIFFERENTIAL CALCULUS

Problems on angle between the radius vector and the tangent

1. Find the angle between the radius vector and tangent to the curve $r^2 \sec 2\theta = a^2$. $Ans: \phi = \frac{\Pi}{2} - 2\theta$

2. Find the angle between the radius vector and tangent and also find the slope of tangent to the curve $r^2 = a^2 \sin 2\theta$ at $\theta = \frac{\Pi}{12}$. $Ans: \phi = 2\theta; \quad \psi = \theta + \phi = \frac{\Pi}{4}, \quad \tan\psi = \tan(\theta + \phi) = \tan\left(\frac{\Pi}{4}\right) = 1.$

3. Find the angle between the radius vector and tangent to the curve $r = \sin\theta + \cos\theta$. $Ans: \phi = \frac{\Pi}{4} + \theta$

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4. Find the angle between the radius vector and tangent to the curve $r^m \cos m\theta = a^m$. $Ans: \phi = \frac{\Pi}{2} - m\theta$.

5. Show that the tangents to the polar curve $r = a(1 + \cos\theta)$ at the point $\theta = \frac{\Pi}{3}$ and $\theta = \frac{2\Pi}{3}$ are respectively parallel and perpendicular to the initial line.

6. Show that at any point (r,θ) on the polar curve $r^n = a^n \sin n\theta$, the tangent to the curve makes an angle $(n+1)\theta$ with the initial line.

Problems on angle between two curves

1. Find the angle of intersection of the curves

$r = a\sec^2\left(\frac{\theta}{2}\right);\quad r = b\cos ec^2\left(\frac{\theta}{2}\right)\quad Ans:\phi_1 = \frac{\Pi}{2} - \frac{\theta}{2};\quad \phi_2 = \frac{-\theta}{2};\quad |\phi_1 - \phi_2| = \frac{\Pi}{2}$

2. Find the angle of intersection of the curves

$r = \frac{a\theta}{1+\theta};\quad r = \frac{a}{1+\theta^2}\quad Ans:\tan\phi_1 = \theta(1+\theta);\quad \tan\phi_2 = \frac{-1}{2\theta}\left(1+\theta^2\right);\quad \tan|\phi_1 - \phi_2| = 3$

3. Find the angle of intersection of the curves $r = a\theta;\quad r = \frac{a}{\theta}$

$Ans:\tan\phi_1 = \theta;\quad \tan\phi_2 = -\theta;\quad \tan\phi_1\tan\phi_2 = -1$

4. Show that the angle of intersection of curves $r = \frac{3\theta}{1+\theta}; r = \frac{10}{1+\theta^2}$ $Ans:\tan^{-1}\left(\frac{29}{26}\right)$.

5. Show that the curves $r = a(1+\cos\theta);\quad r = b(1-\cos\theta)$ cut each other orthogonally.

6. Show that the curves $\frac{2a}{r} = 1-\cos\theta;\quad \frac{2a}{r} = 1+\cos\theta$ cut each other orthogonally.

Problems on pedal equation

1. Find the pedal equation of the curve $2a = r(1+\cos\theta).\quad Ans: p^2 = ar$

2. Find the pedal equation of the curve $\frac{l}{r} = 1 + e\cos\theta.\quad Ans:\frac{1}{p^2} = \frac{e^2r^2 - r^2 + 2lr}{l^2r^2}$

3. Find the pedal equation of the curve $r^m = a^m\sin m\theta + b^m\cos m\theta.\quad Ans: r^{m+1} = p\sqrt{a^{2m} + b^{2m}}$

4. Show that the pedal equation of the curve $r\cos\left(\frac{1}{a}\sqrt{a^2-b^2}\right)\theta = \sqrt{a^2-b^2}$ is $p^2 = \frac{a^2b^2}{r^2+b^2}$.

5. Find the pedal equation of the curve $r\left(1-\sin\frac{\theta}{2}\right)^2 = a.\quad Ans: ar^3 = 4p^4.$

Problems on Radius of curvature
Cartesian Form

1. Find the radius of curvature of the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$ at the point $(x,y).\quad Ans: 3(axy)^{\frac{1}{3}}$

2. Show that the radius of curvature of the curve $y = 4\sin x - \sin 2x$ at the point $x = \frac{\Pi}{2}$ is $\frac{5\sqrt{5}}{4}$.

3. In the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$ show that the radius of curvature at an end point of the major axis is equal to the semi-latus rectum.

4. For the curve $y = \frac{ax}{a+x}$, prove that $\left(\frac{2\rho}{a}\right)^{\frac{2}{3}} = \left(\frac{y}{x}\right)^2 + \left(\frac{x}{y}\right)^2$.

5. Show that the radius of curvature ρ at a point *P* on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is given by $\rho=\frac{(CD)^3}{ab}$, where *CD* is the semi-diameter conjugate to *CP*.

Polar Form

1. Show that the radius of curvature of the curve $r^n=a^n\sin n\theta.$ $Ans:\rho=\frac{a^n}{(n+1)r^{n-1}}$

2. Obtain the pedal equation of the polar curve $r=a\sec 2\theta.$ Hence find the radius of curvature at any point (r,θ) on the curve. $Ans:\rho=\frac{r^4}{3p^3}$

3.Show that, for the curve $r=a\sin n\theta,$ the radius of curvature at the pole is $\frac{na}{2}$.

4.Show that for the curve $r(1-\cos\theta)=2a,$ ρ^2 is proportional r^3,where ρ is the radius of curvature at any point.

5. Show that for the curve $r=a\sin^3\frac{\theta}{3},$ ρ^3 is proportional to r^2.

Parametric Form

1. Find the radius of curvature of the curve $x=e^t\cos t;\quad y=e^t\sin t.\quad Ans:\rho=\sqrt{2}e^t$

2. Find the radius of curvature of the curve $x=a(\theta+\sin\theta);\quad y=a(1-\cos\theta).\quad Ans:\rho=4a\cos\left(\frac{\theta}{2}\right)$

3. Find the radius of curvature of the curve
$x=a\sin 2\theta(1+\cos 2\theta);\quad y=a\cos 2\theta(1-\cos 2\theta).\quad Ans:\rho=4a\cos 3\theta$

4. Show that the radius of curvature at any point t on the curve
$x=a\left(\cos\theta+\log\left(\tan\frac{\theta}{2}\right)\right);\quad y=a\sin\theta.\quad Ans:\rho=a\cos t$

5. Prove that the radius of curvature of a circle $x^2+y^2=a^2$ is a constant.
[Hint: Take $x=a\cos t, y=a\sin t;\quad 0\le t\le\Pi$]

Pedal Form

1. Write *p-r* equation of the polar curve $\theta=\frac{\sqrt{r^2-a^2}}{a}-\cos^{-1}\left(\frac{a}{r}\right)$ and hence find the radius of curvature at any point on the curve. $Ans:p=\sqrt{r^2-a^2};\quad \rho=\sqrt{r^2-a^2}$

2. If ρ_1 and ρ_2 are the radii of curvature at the extremities of a polar chord of the polar curve $r=a(1+\cos\theta),$ prove that $\rho_1^{\,2}+\rho_2^{\,2}=\frac{16a^2}{9}$

3. Find the radius of curvature of the curve $r^3=2ap^2.\quad Ans:\rho=\frac{2}{3}\sqrt{2ar}$

4. Find the radius of curvature of the curve $r^2+3p^2=a^2.\quad Ans:\rho=\sqrt{3}(a^2-r^2)^{\frac{1}{2}}$

5. Find the radius of curvature of the curve
$\frac{1}{p^2}=\frac{1}{a^2}+\frac{1}{b^2}-\frac{r^2}{a^2b^2}.\quad Ans:\rho=a^2b^2\left(\frac{1}{a^2}+\frac{1}{b^2}-\frac{r^2}{a^2b^2}\right)^{\frac{3}{2}}$

Taylor's and Maclaurin's Series

1. Expand $f(x)=\log(\sin x)$ in powers of (*x-2*).
2. Find the Taylor's series expansion of the function $f(x)=\tan^{-1}(x)$ at *a=1*.
3. Obtain the Maclaurin's series expansion of the function $f(x)=\sqrt{1+\sin 2x}$ up to fourth degree terms.
4. Obtain the Maclaurin's series expansion of the function $f(x)=e^{a\sin^{-1}(x)}$
5. Obtain the Maclaurin's series expansion of the function $f(x)=\log(1+e^x)$

UNIT – II

PARTIAL DIFFERENTIATION

1. Evaluate $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ if
   i) $z=x^2y-xsin(xy)$ **Ans:** $\boldsymbol{xy(2-cosxy)-sinxy}$; $\boldsymbol{x^2(1-\cos xy)}$
   ii) $z=cos^{-1}$(x/y) **Ans:** $\frac{-1}{\sqrt{y^2-x^2}}$; $\frac{x}{y\sqrt{y^2-x^2}}$
   iii) $z=tan^{-1}\left(\frac{x^2+y^2}{x+y}\right)$ **Ans:** $\frac{x^2+2xy-y^2}{(x^2+y^2)^2+(x+y)^2}$; $\frac{y^2+2xy-x^2}{(x^2+y^2)^2+(x+y)^2}$
2. If $(x+y)=x^2+y^2$, show that $\left(\frac{\partial z}{\partial x}-\frac{\partial z}{\partial y}\right)^2=4(1-\frac{\partial z}{\partial x}-\frac{\partial z}{\partial y})$.
3. If $u=\exp(ax+by)*f(ax-by)$ then prove that $b\frac{\partial u}{\partial x}+a\frac{\partial u}{\partial y}=2abu$.
4. If $u=\log(\tan x+\tan y+\tan z)$ then show that $\sin 2x\frac{\partial u}{\partial x}+\sin 2y\frac{\partial u}{\partial y}+\sin 2z\frac{\partial u}{\partial z}=2$
5. If $u=f(r)$ *where* $r=\sqrt{x^2+y^2+z^2}$ *then show that* $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}=f''(r)+\frac{2}{r}f'(r)$
6. If $u=\log(x^3+y^3+z^3-3xyz)$ then prove that $\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}+\frac{\partial u}{\partial z}=\frac{3}{x+y+z}$ and hence deduce that $\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}\right)^2 u=\frac{-9}{(x+y+z)^2}$
7. At what rate is the area of a rectangle changing if its length is 15mts and increasing at 3mts/sec while its width is 6mts and increasing at 2mts/sec. **Ans:48**

Problems on Total derivatives

1. Given u=sin(x/y) where $x=e^t$, $y=t^2$, find the total derivative of u w.r.t t. **Ans:** $\boldsymbol{\frac{du}{dt}=\left(1-\frac{2}{t}\right)\frac{e^t}{t^2}\cos\left(\frac{e^t}{t^2}\right)}$
2. If $u=x^2+y^2+z^2$, where $x=e^t$, $y=e^t\sin t$, $z=e^t\cos t$, find the total derivative of u w.r.t t.
   Ans: $\boldsymbol{\frac{du}{dt}=4e^{2t}}$
3. If $u=e^x\sin(yz)$, *where* $x=t^2, y=t-1, z=\frac{1}{t}$, *find* $\frac{du}{dt}$ *at* $t=1$. **Ans:3e**
4. If $u=tan^{-1}\left(\frac{y}{x}\right)$, *where* $x=e^t-e^{-t}$ *and* $y=e^t+e^{-t}$, *find* $\frac{du}{dt}$. **Ans:** $\boldsymbol{\frac{du}{dt}=\frac{-2}{e^{2t}+e^{-2t}}}$

5. The height of a tree increases at a rate of 2ft. per year and the radius increases at 0.1 ft. per year. What rate is the volume of the timber increasing at when the height is 20ft. and the radius is 1.5 ft. (Assume that the tree is a circular cylinder). **Ans: 32.97ft^3/year**

Problems on composite functions

1. If $u = f\left(xz, \frac{y}{z}\right), prove\ that\ x\frac{\partial u}{\partial x} - y\frac{\partial u}{\partial y} - z\frac{\partial u}{\partial z} = 0.$
2. If $u = f(x^2 - y^2, y^2 - z^2, z^2 - x^2)$ prove that $\frac{1}{x}\frac{\partial u}{\partial x} + \frac{1}{y}\frac{\partial u}{\partial y} + \frac{1}{z}\frac{\partial u}{\partial z} = 0$
3. If $\emptyset(cx - az, cy - bz) = 0, show\ that\ ap + bq = c\ where\ p = \frac{\partial z}{\partial x}; q = \frac{\partial z}{\partial y}.$
4. If $z = f(u,v), u = \log(x^2 + y^2), v = \frac{y}{x}$, show that $x\frac{\partial z}{\partial y} - y\frac{\partial z}{\partial x} = (1 + v^2)\frac{\partial z}{\partial v}.$

Problems on Implicit functions

1. For the curve $xe^y + ye^x = 0$ find the equation of the tangent line at the origin.

Ans: y+x=0.

2. Find $\frac{dy}{dx}$ when i)$x^y + y^x = c$ ii)$(cosx)^y = (siny)^x$.

Ans: i) $\boldsymbol{\frac{dy}{dx} = \frac{-yx^{y-1} + y^x logy}{x^y logx + xy^{x-1}}}$ **ii)** $\boldsymbol{\frac{dy}{dx} = \frac{ytanx + logsiny}{logcosx - xcoty}}$

3. If $z = sin\left(\frac{x}{y}\right)$ and $x^2 + y^2 = a^2$find $\frac{dz}{dx}$. **Ans:** $\boldsymbol{\frac{dz}{dx} = \frac{a^2}{y^3}\cos\left(\frac{x}{y}\right)}$
4. If u=sin(x^2+y^2) and $a^2x^2 + b^2y^2 = c^2$, find $\frac{du}{dx}$. **Ans:** $\boldsymbol{\frac{du}{dx} = 2\left(1 - \frac{a^2}{b^2}\right)xcos(x^2 + y^2)}$
5. If$x^3 + 3x^2y + 6xy^2 + y^3 = 1$,find $\frac{dy}{dx}$. **Ans:** $\boldsymbol{\frac{dy}{dx} = -\frac{x^2 + 2xy + 2y^2}{x^2 + 4xy + y^2}}$

Problems on Euler's theorem and extension of Euler's theorem

1. Verify Euler's theorem for the following functions:
   i) u=x^{2}yz-4y^{2}z^2+2xz^3
   ii) u=y^{n}log(x/y)
2. If $u = \frac{x^3y^3z^3}{x^2+y^2+z^2} + \cos\left(\frac{xy+yz+zx}{x^2+y^2+z^2}\right)$, then show that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z} = \frac{7x^3y^3z^3}{x^2+y^2+z^2}$.
3. If $u = \frac{x^3+y^3}{y\sqrt{x}} + \frac{1}{x^7}sin^{-1}\left(\frac{x^2+y^2}{x^2+2xy}\right)$, find the value of $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$at $x = 1, y = 2.$ **Ans:** $\boldsymbol{\frac{81}{8} + \frac{49\pi}{2}}$
4. If $u = sin^{-1}\left(\frac{x-y}{x+y}\right)^{\frac{1}{2}}$ prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 0.$
5. If $u = sin^{-1}\left(\frac{x+y}{\sqrt{x}+\sqrt{y}}\right)$, then show that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = \frac{-sinucos\ 2u}{4cos^3 u}$.
6. Using Euler's theorem, show that if $u = tan^{-1}(x^2 + 2y^2)$, then
   i) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = sin2u$
   ii) $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = 2\text{sinucos3u}$
7. If $u = log\left(\frac{x^2+y^2}{\sqrt{x}+\sqrt{y}}\right)$, find the value of

$i) x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ **Ans:3/2**

$ii)\ x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$ **Ans: -3/2**

8. If $z = \log(x^2 + y^2) + \frac{x^2+y^2}{x+y} - 2\log(x + y)$, find the value of $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y}$. **Ans:** $\frac{x^2+y^2}{x+y}$

Problems on Maxima and Minima for a function of two variables

1. Discuss the maxima and minima of $f(x, y) = xy(a - x - y), a > 0$.
2. Find the extreme values of the function f(x,y) = sinxsinysin(x+y).
   Ans: $f(x, y)$ **is maximum at** $\left(\frac{a}{3}, \frac{a}{3}\right)$ **and** $f_{max} = \frac{1}{27}a^3$

   Ans: $f(x, y)$ **is maximum at** $\left(\frac{\pi}{3}, \frac{\pi}{3}\right)$ **and** $f_{max} = \frac{3\sqrt{3}}{8}$
3. In a plane triangle ABC, find the maximum value of cosAcosBcosC.

Ans: $f(x, y)$ **is maximum at** $\left(\frac{\pi}{3}, \frac{\pi}{3}\right)$ **and** $f_{max} = \frac{1}{8}$

4. Show that the function f(x,y)= x^3+y^3-3axy has a maximum at the point (a,a) if a<0 and a minimum at the point (a,a) if a>0.

Lagarange's method of multipliers

1. Find the maximum and minimum distance from the point (1,2,2) to the sphere $x^2 + y^2 + z^2 = 36$.**Ans: maximum distance =9 and minimum distance=3**
2. A rectangular box open at the top is to have a volume of 32 cubic feet. Find the dimensions of the box requiring least material for its construction. **Ans: x=y=2z=4**
3. Find the volume of the greatest rectangular parallelopiped that can be inscribed in the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$. **Ans: Greatest volume =** $\frac{8abc}{3\sqrt{3}}$
4. A closed rectangular box has length twice its breadth and has constant volume V. Determine the dimensions of the box requiring the least surface area. **Ans: Dimensions are 2** $\left(\frac{3V}{4}\right)^{\frac{1}{3}}, \left(\frac{3V}{4}\right)^{\frac{1}{3}}, \left(\frac{2V}{9}\right)^{\frac{1}{3}}$.
5. The temperature T at a point (x,y,z) in space is T= $400xyz^2$. Find the highest temperature on the surface of the unit sphere $x^2 + y^2 + z^2 = 1$.**Ans: Highest temperature = 50**
6. Prove that of all rectangular parallelopipeds of the same volume, the cube has the least surface area.**Ans: For** $x = y = z = V^{\frac{1}{3}}, the\ surface\ area\ S\ is\ minimum.$

Errors and approximations

1. Find the percentage error in calculating the volume and surface area of a sphere due to an error of x% in the radius. **Ans: error in volume=3x% and error in surface area=2x%**
2. The diameter and altitude of a can in the shape of a right circular cylinder are measured as 4cm and 6cm respectively. The possible error in each measurement is 0.1cm. Find approximately the maximum possible error in the values computed for the volume and the lateral surface.
   Ans: error in volume=1.6πcm^3 and error in lateral surface=πcm^2.

3. If the sides of a plane triangle ABC vary in such a way the its circum radius remains constant, prove that $\frac{da}{cosA}+\frac{db}{cosB}+\frac{dc}{cosC}=0$.
4. The power 'P' required to propel a steamer of length 'l' at a speed 'u' is given by $P=\lambda u^3 l^3$ where λ is a constant. If 'u' is increased by 3% and 'l' is decreased by 1%, find the corresponding increase in 'P'. **Ans: increase in P=6%.**
5. In estimating the cost of pile of bricks measured as 2m x 15m x 1.2m, the tape is stretched 1% beyond the standard length. If the count is 450 bricks to 1 cu.m. and bricks cost Rs. 530 per 1000, find the approximate error in the cost.

   Ans: error in the cost=Rs. 257.58 which is a loss to the brick seller.
6. The period T of a simple pendulum of length l is given by $T=2\pi\sqrt{\frac{l}{g}}$. Find the error and the percentage error made in computing T by using l=2ms. and g=10m/s^2 if the true values are l=2.1ms. and g=9.8m./s^2. **Ans: error in T=2.90855,**

UNIT III INTEGRAL CALCULUS

JACOBIAN

1. If u = x siny, v= y sinx find $\frac{\partial(u,v)}{\partial(x,y)}$ **Ans:** sinx.siny-xy.cosx.cosy.
2. If u = $x^2+y^2+z^2$, v = xy+yz+zx, w= x+y+z, find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$. **Ans:** Zero.
3. Find Jacobian of u, v, w w.r.to x,y,z when u= $\frac{yz}{x}$, v = $\frac{zx}{y}$, w= $\frac{xy}{z}$. **Ans: 4**
4. If u=xyz, v= $x^2+y^2+z^2$, w= x+y+z, find $\frac{\partial(x,y,z)}{\partial(u,v,w)}$. **Ans:** $\frac{1}{2(x-y)(y-z)(z-x)}$.
5. If u= x+y+z, uv = y+z, uvw = z , find $\frac{\partial(x,y,z)}{\partial(u,v,w)}$. **Ans:** u^2v.
6. Calculate $\frac{\partial(x,y,z)}{\partial(u,v,w)}$ if u= $\frac{2yz}{x}$, v = $\frac{3zx}{y}$, w= $\frac{4xy}{z}$ **Ans:** 96.

PROPERTIES OF JACOBIAN

1. If x= u(1-v) , y=uv, prove that JJ'=1.
2. If u = x+$\frac{y^2}{x}$, v =$\frac{y^2}{x}$, prove that JJ'=1.
3. If u = $\frac{x+y}{1-xy}$ and v=$tan^{-1}(x)+tan^{-1}(y)$. Find $\frac{\partial(u,v)}{\partial(x,y)}$. Are u and v functionally related. If so, find this relationship. **Ans:** u = tan v
4. If u = x$\sqrt{1-y^2}+y\sqrt{1-x^2}$ and v=$sin^{-1}(x)+sin^{-1}(y)$. Show that u and v functionally related and find the relationship. **Ans:** u = sin v
5. If u= x^2-y^2, v= 2xy and x = r cos$\boldsymbol{\theta}$, y = rsin$\boldsymbol{\theta}$, find $\frac{\partial(u,v)}{\partial(r,\theta)}$. **Ans:** $4r^3$
6. If x=$\sqrt{vw}$, y=$\sqrt{wu}$, z=$\sqrt{uv}$ and u = rsin$\boldsymbol{\theta}$cos$\boldsymbol{\Phi}$ and v= rsin$\boldsymbol{\theta}$ sin$\boldsymbol{\Phi}$, w= r cos$\boldsymbol{\theta}$, Calculate $\frac{\partial(x,y,z)}{\partial(r,\theta,\Phi)}$ **Ans:** $\frac{1}{4}r^2 sin\theta$

DOUBLE INTEGRAL:

1. Evaluate $\int_3^4\int_1^2\frac{dy\,dx}{(x+y)^2}$. **Ans:** $ln\left(\frac{25}{24}\right)$.
2. Evaluate $\int_0^1\int_x^{\sqrt{x}}(x^2+y^2)dx\,dy$. **Ans:** $\frac{3}{35}$.
3. Evaluate $\int\int xy(x+y)dxdy$ over the area between $y=x^2$ and y = x. **Ans:** $\frac{3}{56}$.

4. Evaluate $\iint_R x^2\,dx\,dy$ where R is the region in the first quadrant bounded by the lines x=y, y=0 , x=8 and the curve xy=16. **Ans:** 448.
5. Evaluate $\int_0^1 \int_0^{\sqrt{1+x^2}} (1+x^2+y^2)^{-1} dx\,dy$. **Ans:** $\frac{\pi}{4}\log(1+\sqrt{2})$.
6. Evaluate $\int\int r^3 dr\,d\theta$ over the area included between the circles r= 2 sinθ and r= 4sinθ. **Ans:** 22.5π.
7. Evaluate $\int\int r\sin\theta\,dr\,d\theta$ over the cardioid r = a(1-cosθ) above the initial line. **Ans:** $\frac{4a^2}{3}$.

CHANGE OF VARIBLES IN DOUBLE INTEGRAL(POLAR):

Evaluate the following integral by changing into polar coordinates:

1. $\int_0^2 \int_0^{\sqrt{2x-x^2}} \frac{x\,dy\,dx}{\sqrt{x^2+y^2}}$. **Ans:** 4/3
2. $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)}$dy dx. Hence show that $\int_0^\infty e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$. **Ans**: $\pi/4$.
3. $\int_0^a \int_y^a \frac{x^2 dx\,dy}{\sqrt{x^2+y^2}}$. **Ans:** $a^3\log(\sqrt{2}+1)/3$.
4. $\iint_R \sqrt{x^2+y^2}\,dx\,dy$, where R is the region in the xy-plane bounded by the circles $x^2+y^2=4$. **Ans:** $38\pi/3$.
5. $\iint \frac{(x^2+y^2)^2 dx\,dy}{x^2y^2}$over the area common to $x^2+y^2=ax$ and $x^2+y^2=bx$, a,b>0. **Ans:** ab.
6. $\iint \frac{(x-y)^2 dx\,dy}{x^2+y^2}$over the circle $x^2+y^2\le 1$. **Ans:** π-2.

CHANGE OF ORDER OF INTEGRATION:

Evaluate by changing the order of integration:

1. $\int_0^\infty \int_0^\infty e^{-xy}\sin px\,dx\,dy$ and show that $\int_0^\infty \frac{\sin px}{x} dx = \frac{\pi}{2}$.
2. $\int_0^1 \int_{x^2}^{2-x} xy\,dx\,dy$. **Ans**: $\frac{3}{8}$
3. $\int_0^\infty \int_0^x e^{-xy}\,y\,dy\,dx$. **Ans**: $\frac{\sqrt{\pi}}{2}$
4. $\int_0^{a/\sqrt{2}} \int_x^{\sqrt{a^2-x^2}} y^2$dy dx. **Ans**: $a^4\frac{(\pi+2)}{32}$
5. $\int_0^b \int_y^a \frac{x\,dy\,dx}{x^2+y^2}$dy dx. **Ans**: $\frac{\pi ab}{4}$
6. $\int_0^a \int_0^{bx/a} x\,dy\,dx$. **Ans**: $\frac{1}{3}a^2b$.

TRIPLE INTEGRALS:

Evaluate

1. $\int_0^2 \int_1^z \int_0^{yz} xyz\,dx\,dy\,dz$. **Ans**: $\frac{7}{2}$

2. $\int_1^e \int_1^{logy} \int_1^{e^x} logz\ dz\ dx\ dy.$ **Ans:** $\frac{1}{4}(e^2 - 8e + 13).$
3. $\int_0^1 \int_0^{1-x} \int_0^{1-x-y} \frac{1}{(x+y+z+1)^3}\, dx\ dy\ dz$ **Ans:** $-\frac{1}{2}\left(\frac{5}{8} - log2\right).$
4. $\int_0^4 \int_1^{2\sqrt{z}} \int_0^{\sqrt{4z-x^2}}\ dy\ dx\ dz.$ **Ans**: $8\boldsymbol{\pi}.$
5. $\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}}\ xyz\ \ dz\ dy\ dx.$ **Ans:** $\frac{a^6}{48}.$
6. $\int\int\int (x^2 + y^2\ )dx\ dy\ dz$, over the region bounded by the paraboloid $x^2 + y^2 = 3z$ and the plane z=3. **Ans:**$\frac{81\pi}{2}.$

CHANGE OF VARIABLES IN TRIPLE INTEGRAL (SPHERICAL AND CYLINDRICAL):

1. Use Spherical coordinates to evaluate $\int_0^1 \int_0^{\sqrt{1-x^2}} \int_0^{\sqrt{1-x^2-y^2}} \frac{1}{\sqrt{1-x^2-y^2-z^2}} dx\ dy\ dz.$
   Ans:$\frac{\pi^2}{8}.$
2. Evaluate $\int\int\int xyz\ dx\ dy\ dz$ over the positive octant of the sphere $x^2 + y^2 + z^2 = b^2$ by transforming to spherical polar coordinates. **Ans:**$\frac{b^6}{48}.$
3. Find the Volume of the portion of the sphere $x^2 + y^2 + z^2 = a^2$ lying inside the cylinder $x^2 + y^2 = ay.$ **Ans:**$\frac{2a^3(3\pi-4)}{9}.$
4. Evaluate $\int\int\int \sqrt{x^2 + y^2}\ dx\ dy\ dz$ over the volume bounded by the right circular cone $x^2 + y^2 = z^2$, z > 0 and the planes z=0 and z=1. **Ans:**$\frac{\pi}{6}.$
5. Evaluate $\int\int\int z^2\ dx\ dy\ dz$ over the volume bounded by the cylinder $x^2 + y^2 = a^2$and the paraboloid $x^2 + y^2 = z$ and the plane z=0 . **Ans:**$\frac{\pi a^8}{12}.$
6. Evaluate $\int\int\int xyz\ dx\ dy\ dz$ over the region bounded by the planes x=0, y=0, z=0 and z=1 and the cylinder $x^2 + y^2 = 1.$ **Ans:**$\frac{1}{16}.$

APPLICATION OF MULTIPLE INTEGRALS -CENTRE OF MASS, MOMENT OF INERTIA, AREA AND VOLUME:

1. Find the mass and center of mass of a triangular lamina with vertices (0,0),(1,0) and (0,2) if the density function is 1+3x+y. **Ans:** Mass= 8/3. Center of Mass(3/8,11/16).
2. The density at any point on a semi-circular lamina is proportional to the distance from the center of the circle. Find the center of mass of the lamina. **Ans:** Center of Mass(0, 3a/2□).
3. Find the moment of inertia of a right circular cone relative to its axis. **Ans**: $\frac{\pi hr^4}{10}$
4. Find the moment of inertia of a quadrant of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ of mass M about the Z-axis , if the density at a point is proportional to xy. **Ans:** $\frac{1}{3}M(a^2 + b^2).$
5. Find the area of the curve by $a^2x^2 = y^3(2a - y)$double integration. **Ans**: πa^2
6. Find the volume of the solid surrounded by the surface $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} + \left(\frac{z}{c}\right)^{2/3} = 1$ **Ans:**$\frac{4abc}{35}$

UNIT IV ORDINARY DIFFERENTIAL EQUATIONS

Solve the following differential equations

1. $(sinxsiny - xe^y)dy = (e^y + cosxcosy)dx$ $\boldsymbol{Ans}: xe^y + sinx\ cosy = c$
2. $(y - x^3)dx + (x + y^3)dy = 0$ $\boldsymbol{Ans}: 4xy - x^4 + y^4 = c$

3. $2xydy - (x^2 + y^2 + 1)dx = 0$ $\boldsymbol{Ans}: y^2 - x^2 + 1 = cx$
4. $y(x + y)dx + (x + 2y - 1)dy = 0$ $\boldsymbol{Ans}: y(x - 1 + y) = ce^{-x}$
5. $(y^4 + 2y)dx + (xy^3 + 2y^4 - 4x)dy = 0$ $\boldsymbol{Ans}: (y^3 + 2)x + y^4 = cy^2$
6. $(x^4 + y^4)dx - xy^3dy = 0$ $\boldsymbol{Ans}: y^4 = 4x^4 logx + cx^4$
7. $(xysinxy + cosxy)ydx + (xysinxy - cosxy)xdy = 0$ $\boldsymbol{Ans}: x\, secxy = cy$
8. $y(1 + xy)dx + (1 - xy)xdy = 0$ $\boldsymbol{Ans}: log\frac{x}{y} - \frac{1}{xy} = c$
9. $y' + y = e^{e^x}$ $\boldsymbol{Ans}: ye^x = e^{e^x} + c$
10. $ydx + (3x - xy + 2)dy = 0$ $\boldsymbol{Ans}: xy^3 = 2y^2 + 4y + 4 + ce^x$
11. $ydx - (x + 2y^3)dy = 0$ $\boldsymbol{Ans}: x = y^3 + cy$
12. $dx - (x^2y^3 + xy)dy = 0$ $\boldsymbol{Ans}: x(2 - y^2) + cxe^{\frac{-x^2}{2}} = 1$

Find the Orthogonal Trajectories of family of following curves

1. $x^2 + y^2 = c^2$ $\boldsymbol{Ans}: y = kx$
2. $y = cx^2$ $\boldsymbol{Ans}: \frac{x^2}{2} + y^2 = c^x$
3. $r = a(1 + sin^2\theta)$ $\boldsymbol{Ans}: r^2 = b\, cos\theta\, cot\theta$
4. $r = 4a\, sec\theta\, tan\theta$ $\boldsymbol{Ans}: r^2(1 + sin^2\theta) = b^2$
5. Find constant e such that $y^3 = c_1x \quad and\ x^2 + e\, y^2 = c_2$ are orthogonal to each other. $\boldsymbol{Ans}: e = \frac{1}{3}$
6. Show that the family of parabolas $y^2 = 2cx + c^2$is self orthogonal.

Solve the following equations

1. $p^2 - 5p + 6 = 0$ $\boldsymbol{Ans}: (y - 3x - c)(y - 2x - c) = 0$
2. $yp^2 + (x - y)p - x = 0$ $\boldsymbol{Ans}: (y - x - c)(y^2 + x^2 - c) = 0$
3. $p^2x^4 - px - y = 0$ $\boldsymbol{Ans}: y = c^2x - c$
4. $p\, tanp - y + log\, cos\, p = 0$ $\boldsymbol{Ans}: x = tanp + c, y = p\, tan\, p + log\, cos\, p$
5. $6p^2y^2 - y + 3px = 0$ $\boldsymbol{Ans}: y^3 = 3cx + 6c^2$
6. $y = 2px + p^n$ $\boldsymbol{Ans}: y = \frac{2c}{p} + \frac{1-n}{1+n}p^n$

Application Problems

1. Water at 100^0C cools in 10 min to 80^0C in a room tempereature25^0Ca) Find the temperature of water after 20 min. Find the time at which the temperature drops to b0 $40^0Cc)\ 26^0C$ $\boldsymbol{Ans}: a)\ 65.3^0C \quad b)\ 52\ min.\ c)139\ min.$
2. A body is heated to 110^0C and placed in air at 10^0C. After 1 h its temperature is 60^0C. How much additional time is require for it to cool to 30^0C $\boldsymbol{Ans}: 1.3223 hours$
3. Find the shape of a reflector such that light coming from a fixed source is reflected in parallel rays. **Ans**:$y^2 + z^2 = 2cx + c^2$
4. A body initially at 80^0C cools down to 60^0C in 20 mins, the temperature of the air being 40^0C . What will be the temperature of the body after 40 mins. From the original. **Ans**: 50^0C

UNIT – V HIGHER ORDER DIFFERENTIAL EQUATIONS

Solve the following differential equations

1. $y''' - 6y'' + 12y' - 8y = 0$ $\boldsymbol{Ans}: y = (c_1 + c_2x + c_3x^2)e^{2x}$
2. $y'''' - 3y''' + 2y' = 0. y(0) = 2, y'(0) = 0, y''(0) = 2, y'''(0) = 2$ $\boldsymbol{Ans}: y = 2(e^x - x).$
3. $y'''' - 4y''' + 14y'' - 20y' + 25y = 0$ $\boldsymbol{Ans}: y = (c_1 + c_2x)sin2x + (c_3 + c_4x)cos2x.$
4. $y'''' - 2y'''' + y''' = 0$ $\boldsymbol{Ans}: y = c_1 + c_2x + c_3x^2 + (c_4 + c_5x)e^x$

5. $(D^3-2D^2-5D+6)y=2e^x+4e^{3x}+7e^{-2x}+8e^{2x}+15$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{3x}+c_3e^{-2x}-\frac{1}{3}xe^x+\frac{2}{5}xe^{3x}+\frac{7}{15}xe^{-2x}-2e^{2x}+\frac{15}{16}$
6. $(D^2-p^2)y=sinhpx$ $\boldsymbol{Ans}$: $y=c_1e^{px}+c_2e^{-px}+\frac{x}{2p}coshpx$
7. $(2D^2-2D+1)y=sin3x\,cos2x$ $Ans: y=e^x\left(c_1cos\frac{x}{2}+c_2sin\frac{x}{2}\right)+\frac{10cos5x-49sin5x}{5002}+\frac{2cosx-sinx}{10}$
8. $(D^2+4D+4)y=x^2+2x$ $with\ y(0)=0, y'(0)=0$ $\boldsymbol{Ans}$: $y=\frac{-3}{8}[(1+2x)e^{-2x}+\frac{1}{8}(2x^2+3)]$
9. $(D^4-1)y=cosx\,coshx$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{-x}+c_3cosx+c_4coshx-\frac{1}{5}cosxcoshx$
10. $(D^2-1)y=xsinx+x^2e^x$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{-x}-\frac{1}{2}(xsinx+cosx)+\frac{xe^x}{12}(12x^2-3x+12)$
11. $(D^2-6D+9)y=6e^{3x}+3x^2e^{3x}+\frac{7}{25}e^{-2x}-\frac{1}{9}log2$ $\boldsymbol{Ans}$: $y=(c_1+c_2x)e^{3x}+3x^2e^{3x}+\frac{7}{25}e^{-2x}-\frac{1}{9}log2$
12. $(D^4-1)y=cosxcoshx$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{-x}+c_3cosx+c_4sinx-\frac{1}{5}cosx\,coshx$
13. $(D^4+D^2+1)y=e^{\frac{-x}{2}}cos\frac{\sqrt{3}}{2}x$

$\boldsymbol{Ans}$: $y=e^{\frac{-x}{2}}[\left(c_1+\frac{x}{4}\right)cos\frac{\sqrt{3}}{2}x+\left(c_3+\frac{x}{4\sqrt{3}}\right)sin\frac{\sqrt{3}}{2}x+e^{\frac{x}{2}}(c_3cos\frac{\sqrt{3}}{2}x+c_4sin\frac{\sqrt{3}}{2}x]$

14. $(D^3+2D^2+D)y=x^2e^{2x}+sin^2x$

$\boldsymbol{Ans}$: $y=c_1+(c_2+c_3x)e^{-x}+\frac{e^{2x}}{18}\left(x^2-\frac{7x}{8}+\frac{11}{6}\right)+(\frac{1}{100}(3sin2x+4cos2x)$

15. $(D^2+2)y=x^2e^{3x}+e^xcos2x$ $\boldsymbol{Ans}$: $y=c_1cos\sqrt{2x}+c_2sin\sqrt{2x}+\frac{e^{3x}}{11}\left(x^2-\frac{12}{11}x+\frac{50}{121}\right)+(\frac{e^x}{17}(4sin2x-cos2x)$
16. $(D-2)^2=8(e^{2x}+sin2x+x^2)$ $Ans: y=(c_1+c_2x)e^{2x}+4x^2e^{2x}+cos2x+2x^2+4x+3(D^2-2D+1)y=xe^xsinx$ $\boldsymbol{Ans}$: $y=(c_1+c_2x)e^x-e^x(xsinx+2cosx)$

Solve the following differential equations by the method of variation of parameters.

1. $y''-2y'+y=e^xlogx$ $\boldsymbol{Ans}$: $y=(c_1+c_2x)e^x+\frac{1}{4}x^2e^x(2logx-3)$
2. $y''+a^2y=secax$ $\boldsymbol{Ans}$: $y=c_1cosax+c_2sinax+\frac{1}{a^2}cosaxlogcosax+\frac{1}{a}xsinax$
3. $y''+y=\frac{1}{1+sinx}$ $\boldsymbol{Ans}$: $y=c_1cosx+c_2sinx+sinxlog(1+sinx)-xcosx-1$
4. $y''-3y'+2y=\frac{e^x}{1+e^x}$ $\boldsymbol{Ans}$: $y=(e^x+e^{2x})log(1+e^x)+(c_1-1-x)e^x+(c_2-x)e^{2x}$
5. $(D^2+2D+1)y=e^{-x}logx$ $\boldsymbol{Ans}$: $y=c_1e^{-x}+c_2xe^{-x}+\frac{x^2}{2}\left(\frac{1}{2}-logx\right)e^{-x}+e^{-2x}(xlogx-x)$
6. $(D^2-3D+2)y=\frac{1}{1+e^{-x}}$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{2x}+e^x.loge^{2x}(log(1+e^{-x})-e^{-x})$
7. $(D^2-1)y=e^{-x}sine^{-x}+cose^{-x}$ $\boldsymbol{Ans}$: $y=c_1e^x+c_2e^{-x}-e^xsine^{-x}$

Solve the following Cauchy's and Legendre's differential equations

1. $x^2y''-3xy'+5y=x^2sin(logx)$ $\boldsymbol{Ans}$: $y=x^2(c_1coslogx+c_2sinlogx)-logx+\frac{x^2}{2}cos(logx)$
2. $x^2y''-xy'+4y=coslogx+xsinlogx$ $\boldsymbol{Ans}$: $y=c_1xcos\sqrt{3}logx+c_2sin\sqrt{3}logx+\frac{1}{13}(3coslogx-2sinlogx)+\frac{x^2}{2}sinlogx+\frac{1}{2}x\,sinlogx$
3. $x^2y''-2xy'+2y=log^2x-logx^2$ $\boldsymbol{Ans}$: $y=c_1x+c_2x^2+\frac{1}{2}[log^2x+logx]+\frac{1}{4}$
4. $((x+1)^3y''+3(x+1)^2y'+(x+1)y=6log(x+1)$ $\boldsymbol{Ans}$: $y(x+1)=c_1+c_2log(x+1)+log3(x+1)$
5. $(2x+3)^2y''+(2x+3)y'-2y=24x^2$ $\boldsymbol{Ans}$: $y=c_1u^{\frac{-1}{2}}+c_2u+\frac{3}{5}u^2-6ulogu-27, u=2x+3$

6. $(1+4x)^2y'' + (1+4x)y' + 4y = 8(1+4x)^2$ ***Ans***: $y = c_1(1+4x)^a + c_2(1+4x)^b + \frac{8}{41}(1+4x)^2, a = 6+2\sqrt{5}\ ,\ b = 6-2\sqrt{5}$

Application problems on differential equations

1. A condenser of capacity C is discharged through an inductance L and a resistance R, in series, and the charge q at time t satisfies the equation $L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{q}{E} = 0$ given that L = 0.25 henries, R=250 ohms, C=2x10 $^{-6}$ farads, and that when t = 0, the charge q = 0.002 coulombs and the current is zero, obtain the value of q in terms of t. **Ans**: $q = e^{-500t}\left(0.002\cos 500\sqrt{7}t + 0.0008\sin 500\sqrt{7}t\right)$.
2. A cantilever beam of length l and weighing $w\ lb/unit$ is subjected to a horizontal compressive force F applied at the free end. Taking the origin at the free end and y-axis upwards, establish the differential equation of the beam and hence find the maximum deflection.**Ans**: $\delta = \frac{\omega}{Pn^2}[1 - \frac{l^2n^2}{2} - secnl + nl\ tannl$
3. A 32 lb weight is suspended from a spring having constant 4 lb/ft. Prove that the motion is one of resonance if a force 16sin2t is applied and damping force is negligible.Assume that initially the weight is at rest in the equilibrium position.
4. Determine the current $I(t)$ in RLC circuit with $a) emf E(t) = E_0 coswt\ , b)\ emf\ mf E(t) = E_0 sinwt$ ***Ans***: $a) I_p = \frac{E_0}{\sqrt{R^2+S^2}}\cos(wt-\delta), b) I_p = \frac{E_0}{\sqrt{R^2+S^2}}\sin(wt-\delta)$
5. A weight 6 lbs hangs from a spring with constant k=12 and no damping force exists. Find the motion of the when an external force $3cos\delta t$ acts. Initially $x = 0\ and\ \ddot{x} = 0$. Determine whether resonance occurs. **Ans**:$x(t) = tsin8t. resonance\ occurs$
6. A horizontal tie rod is freely pinned at each end. It carries a uniform load w lb per unit length and has a horizontal pull P. Find the central deflection and the maximum bending moment, taking the origin at one of its ends. **Ans**: $Maximum\ bending\ moment = \frac{w}{a}\left(sech\frac{al}{2} - 1\right),\ central\ deflection = \frac{w}{Pa^2}\left(sech\frac{al}{2} - 1\right) + \frac{wl^2}{8P}$

Solve the following initial value problem using power series.

1. $xy'' + y' + 2y = 0\ with\ y(1) = 2,\ y'(1) = 4$ ***Ans***: $y = 2 + 4(x-1) - 4(x-1)^2 + \frac{4}{5}(x-1)^3 - \frac{1}{3}(x-1)^4 + \frac{2}{15}(x-1)^5 + \cdots$
2. Solve the following problem using power series$(1-x^2)y' - y = 0$ ***Ans***: $y = c_0(1 + x + \frac{x^2}{2} + \frac{x^3}{2} + \frac{3}{8}x^4 + \cdots$
3. Solve the following problem using power series$y' - 2xy = 0$ ***Ans***: $y = c_0e^{x^2}$
4. Solve the following problem using power series$y'' + xy' + (x^2+2)y = 0$ ***Ans***: $y = c_0\left(1 - x^2 + 14x4+\ldots + c2(x - 12x3 + 340x5 + \ldots)\right.$
5. Solve the following using Frobenius Method $8x^2y'' + 10xy'$-(1+x)y=0**Ans**: $y = Ay_1(x) + By_2(x), y_1(x) = \sum_{n=0}^{\infty} c_n x^{n+\frac{1}{2}},\ \ y_1(x) = \sum_{n=0}^{\infty} c_n x^{n+\frac{1}{2}}$
6. Solve the following using Frobenius method $2x^2y'' - xy' + (x-5)y = 0$

Ans: $y = c_1x^{\frac{5}{2}}\left(1 - \frac{1}{9}x + \frac{1}{198}x^2 - \cdots\right) + c_2x^{-1}(1 + \frac{1}{5}x + \frac{1}{30}x^2 + \frac{1}{90}x^3 + \cdots)$

UE19MA151 Engineering Mathematics – II (3-1-1-0-4)

LESSON PLAN

Class	Title Reference	Portions to be covered	Percentage Covered/ Marks allotted
1-2	**UNIT-I Vector Calculus**	Introduction to Vector differentiation, Vector differential operator ∇ and Laplacian operator ∇^2, Gradient of a scalar point function.	20% 20 Marks
3-4		Directional derivative , Angle between the surfaces-Problems	
5		Divergence and curl of a vector point function, Solenoidal and irrotational vectors-Problems	
6(L-1)		Evaluations gradient, divergence and curl of scalar and vector functions	
7-8		Introduction to Vector integration ; Line, surface and volume integrals-Problems	
9-11		Greens, Stokes' and the Divergence theorem-Problems	
12(L-2)		Evaluation of Line integrals, surface integrals, Volume integrals.	
13(L-3)		Evaluation of Integrals using Green's, Stokes' and Divergence theorem	
14	**UNIT-II Special Functions**	Definitions of Gamma, Beta functions, Graph of Gamma function, properties and recurrence relations	40% 20 Marks
15-16		Relation between Beta and Gamma functions and Duplication formula(Statement only)	
17-18		Problems on Beta and Gamma functions	
19		Evaluation of Beta and Gamma functions	
20(L-3)		Introduction to Bessel's differential equation and its general solution, Bessel's function and Recurrence relations	
21-22		Generating function, Jacobi series	
		Bessel's Integral formula and Orthogonality of Bessel functions	
23(L-4)		Evaluation of Bessel functions	
24-25	**UNIT-III Laplace Transform**	Introduction to Integral transforms, Definition of Laplace Transforms, Laplace transforms of standard functions	60% 20 Marks
26-27		Properties of Laplace Transforms: Linearity, First	

		shifting, Change of scale-Problems	
28-29		Multiplication by t^n and Division by t , L.T of derivatives & Integrals-Problems	
30		Evaluation of Laplace transform of functions using Maxima	
31		Laplace Transform of periodic functions	
32-33		Definition of Unit step function-Problems Definition of Unit impulse function- problems	
34(L-5)		Evaluation of Laplace transform of functions using Maxima	
35	**UNIT- IV Inverse Laplace Transform**	Definition of Inverse Laplace transforms, Inverse Laplace transforms of standard functions, Properties of ILT	80% 20 Marks
36-37		Different methods of finding inverse Laplace transforms and problems	
38-39		Convolution theorem (without proof) and problems on convolution theorem	
40-41		Solutions of Linear Differential Equations by LT with given initial conditions	
42 (L-6,7)		Solving differential equations and system of differential equations using Maxima	
43	**UNIT V Fourier Series**	Introduction to Fourier series, Periodic function, Dirichlet's conditions, Euler's formulae, convergence of FS at the discontinuous point and at end points	100% 20 Marks
44-45		Problems on Fourier Series in the intervals $(-\pi,\pi),(0,2\pi)$ and in the arbitrary intervals	
46		Half Range Fourier Series -Problems	
47		Parseval's Formula & Problems	
48-49		Harmonic Analysis, Complex form of Fourier Series	
50(L-8)		Fourier series , Harmonic Analysis	
51(L-9)		Repetition of Labs	
52(L-10)		LAB TEST	
53-56		Revision classes	

Question Bank

UNIT – I VECTOR CALCULUS

1. Find the unit normal to the following surfaces

   i. $x^2+3y^2+z^2=28 \text{ at } P:(4,1,3)$ **Ans**: $\frac{1}{2\sqrt{34}}\left(8\hat{i}+6\hat{j}+6\hat{k}\right)$

   ii. $z=x^2+y^2 \text{ at } P:(3,4,25)$ **Ans**: $\frac{1}{\sqrt{101}}\left(6\hat{i}+8\hat{j}-\hat{k}\right)$

   iii. $x^2y+2xz=4 \text{ at } P:(2,-2,3)$ **Ans:** $\frac{1}{3}\left(-\hat{i}+2\hat{j}+2\hat{k}\right)$

2. Find the angle between the surfaces $x^2+y^2+z^2=9$ and $z=x^2+y^2-3$ at the point (2, -1, 2) **Ans**: $8/3\sqrt{21}$

3. Find the directional derivative of f at **P** in the direction of $\vec{a}$

   i. $f=x^2+y^2-z,\ P:(1,1,-2),\vec{a}=[1,1,2]$ **Ans**: $\sqrt{2/3}$

   ii. $f=xyz,\ P:(-1,1,3),\vec{a}=[1,-2,2]$ **Ans**: $7/3$

4. In what direction from (3, 1, -2) is the directional derivative of $f=x^2y^2z^4$ maximum. Find also the magnitude of the maximum. **Ans: 96 *i* + 288 *j* – 288 *k* ,** $96\sqrt{19}$
5. Find the direction in which temperature changes most rapidly with distance from the points (1, 1, 1) and determine the maximum rate of change if the temperature at any point is given by $f=xy+yz+zx$

   Ans: $2\hat{i}+2\hat{j}+2\hat{k}$, $\sqrt{12}$
6. Determine the constant **a** so that the vector $\vec{F}=(x+3y)\hat{i}+(y-2z)\hat{j}+(x+az)\hat{k}$ is solenoidal. (**Ans**: $a=-2$)
7. Find **a** so that the vector $\vec{F}=(axy-z^3)\hat{i}+(a-2)x^2\hat{j}+(1-a)xz^2\hat{k}$ is irrotational.(**Ans:** $a=4$)
8. If $\vec{F}=(xy^2)\hat{i}+(2x^2yz)\hat{j}-(3yz^2)\hat{k}$, find $\nabla\times\vec{F}$ at the point (1, -1, 1). (**Ans:** $-\hat{i}-2\hat{k}$)
9. Show that the vector field $\vec{F}=(z^2+2x+3y)\hat{i}+(3x+2y+z)\hat{j}+(y+2zx)\hat{k}$ is irrotational but not solenoidal. Also obtain a scalar function ϕ such that $\nabla\phi=\vec{F}$. **Ans**: $\phi=xz^2+3xy+yz+x^2+y^2+c$

10. Verify Green's theorem in the plane for the integral $\oint_c \{(x-y)dx-(y^2+xy)dy\}$, where c is the circle with unit radius, cantered on the origin.
11. How much work is required to an object in the vector field $\vec{F}=2xyz\,\hat{i}+x^2z\,\hat{j}+x^2y\,\hat{k}$ along the path joining between the two points from $A(0,0,0)$ to $B(2,4,6)$? (**Ans**: 96)
12. Verify Stokes' theorem for a vector field $\vec{F}=xy\,\hat{i}+x^3\,\hat{j}+xz\,\hat{k}$ over the surface $z=x^2+y^2$ bounded by the planes $z=0$ and $z=4$. (**Ans**: 12π)
13. A surface S consists of that part of the cylinder $x^2+y^2=9$ between $z=0\ and\ z=4\ \ for\ y\geq 0$ and two semicircles of radius 3 in the planes $z=0\ and\ z=4$. If $\vec{F}=z\,\hat{i}+xy\,\hat{j}+xz\,\hat{k}$, find the work done over the surface S.(**Ans**: -24)
14. A vector field $\vec{F}=y\,\hat{i}+2\,\hat{j}+\hat{k}$ exists over a surface S defined by $x^2+y^2+z^2=9$ bounded by $x=0,y=0,z=0$ in the first octant. Find the flux of $\vec{F}$ over the surface indicated. (**Ans**: $9\left(1+\frac{3\pi}{4}\right)$)
15. Find the flux of a vector field $\vec{F}=x^2\,\hat{i}+y^2\,\hat{j}+z^2\,\hat{k}$ across the boundary of a rectangular box, $V: 0\leq x\leq a,\ 0\leq y\leq b, 0\leq z\leq c$. (**Ans**: $abc(a+b+c)$)
16. Find the flux of the vector field $k\frac{\vec{r}}{r}$ across the sphere of radius R centered at origin, where $\vec{r}=\langle x,y,z\rangle$ is the position vector (**Ans**: $4\pi R^2k$)
17. Verify the Gauss Divergence theorem for the vector field $\vec{F}=k\frac{\vec{r}}{r}$, over the surface of the sphere $x^2+y^2+z^2=R^2$ where $\vec{r}=\langle x,y,z\rangle$ is the position vector. (**Ans**: $4\pi R^2k$)
18. Find the flux of the water through the parabolic cylinder $y=x^2$, between the planes $x=0,z=0,x=3,z=2$, if the velocity vector is $\vec{F}=y\,\hat{i}+2\,\hat{j}+xz\,\hat{k}\ m/\sec$. (**Ans**: $69\,m^3/\sec$)
19. If $\vec{F}=(2x-y+2z)\hat{i}+(x+y-z)\,\hat{j}+(3x-2y-5z)\hat{k}$, calculate the circulation of $\vec{F}$ along the circle in the $xy-plane$ of radius 2 and centre at origin. (**Ans**: 8π)
20. Using Green's theorem find the area of the region bounded by $y=x^2$ and $y=x+2$. (**Ans**: 9/2)

UNIT – II SPECIAL FUNCTIONS

Gamma and Beta Functions

I. Compute a) $\Gamma(4.5)$ b) $\Gamma(-3.5)$ c) $\Gamma\left(\frac{1}{4}\right)\Gamma\left(\frac{3}{4}\right)$ d) $\beta\left(\frac{5}{2},\frac{3}{2}\right)$

Ans: 11.62875, 0.270019, 4.444, 0.1964

II. Evaluate the following integrals

1) $\int_0^\infty x^7 e^{-x}\,dx$; Ans: 5040

2) $\int_0^\infty x^3 e^{-4x}\,dx$; Ans: $\frac{3}{128}$

3) $\int_0^\infty x^{1/2} e^{-x^2}\,dx$; Ans: $\frac{1}{2}\Gamma\left(\frac{3}{4}\right)$

4) $\int_0^1 x^5 (1-x)^4\,dx$; Ans: $\frac{1}{1260}$

5) $\int_0^3 \frac{x^3}{\sqrt{3-x}}\,dx$; Ans: 42.76

6) $\int_0^{\pi/2} \sin^5\theta \cos^4\theta\, d\theta$; Ans: $\frac{8}{315}$

7) $\int_0^{\pi/2} \sqrt{\tan\theta}\, d\theta$; Ans: 2.2214

8) $\int_0^1 \frac{1}{\sqrt{-x\log x}}\,dx$; Ans: $\sqrt{\pi}$

9) $\int_0^\infty \sqrt{y}\, e^{-y^2}\,dy$; Ans: $\frac{\sqrt{\pi}}{3}$

10) $\int_0^1 x^4 \left[\log\left(\frac{1}{x}\right)\right]^3 dx$; Ans: $\frac{6}{625}$

Bessel's Functions

1. Obtain the series solution of the Bessel's differential equation

   $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + \left(x^2 - n^2\right)y = 0$, where n is real constant

2. Prove the following recurrence relations using Bessel's functions

   i) $2nJ_n(x) = x\left[J_{n-1}(x) + J_{n+1}(x)\right]$ ii) $J_n'(x) = \frac{1}{2}\left[J_{n-1}(x) - J_{n+1}(x)\right]$

   iii) $\frac{d}{dx}\left\{x^n J_n(x)\right\} = x^n J_{n-1}(x)$ iv) $\frac{d}{dx}\left\{x^{-n} J_n(x)\right\} = -x^{-n} J_{n+1}(x)$

   v) $xJ_n'(x) = xJ_{n-1}(x) - nJ_n(x)$ vi) $xJ_n'(x) = nJ_n(x) - xJ_{n+1}(x)$

3. Find the Bessel's function of order $n = \pm\frac{1}{2}$

   Ans: $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x,\quad J_{-1/2}(x) = \sqrt{\frac{2}{\pi x}}\cos x$

4. Find the Bessel's function of order $n = \frac{3}{2}, \frac{5}{2}$

   Ans: $J_{3/2}(x) = \sqrt{\frac{2}{\pi x}}\left(\frac{\sin x}{x} - \cos x\right),\quad J_{5/2}(x) = \sqrt{\frac{2}{\pi x}}\left(\frac{3-x^2}{x^2}\sin x - \frac{3}{x}\cos x\right)$

5. Find the expressions for J_0 and J_1

6. Express J_3 and J_4 in terms of $J_0(x)$ and $J_1(x)$

Ans: $J_3(x)=\left(\frac{8}{x^2}-1\right)J_1(x)-\frac{4}{x}J_0(x),\ J_4(x)=\left(\frac{48}{x^3}-\frac{8}{x}\right)J_1(x)+\left(1-\frac{24}{x^2}\right)J_0(x)$

7. Prove that: a) $\int J_3(x)dx=c-J_2(x)-\frac{2}{x}J_1(x)$

   b) $\int xJ_0^2(x)dx=\frac{1}{2}x^2\left[J_0^2(x)+J_1^2(x)\right]$

8. Find the generating function for $J_n(x)$ Ans: $e^{\frac{x}{2}\left(t-\frac{1}{t}\right)}=\sum_{n=-\infty}^{\infty}t^nJ_n(x)$

9. Prove that $\int_0^a xJ_n(\alpha x)\ J_n(\beta x)dx=\begin{cases}0 & if\ \alpha\neq\beta\\ \frac{a^2}{2}J_{n+1}^2(\alpha a) & if\ \alpha=\beta\end{cases}$

10. Prove the following Jacobi series

    i. $\cos(x\sin\theta)=J_0+2\left[J_2\cos(2\theta)+J_4\cos(4\theta)+.....\right]$

    ii. $\sin(x\sin\theta)=2\left[J_1\sin(\theta)+J_3\sin(3\theta)+J_5\sin(5\theta).....\right]$

11. Using the Jacobi series, prove the following

    i. $\cos(x)=J_0-2J_2+2J_4-2J_6.....$

    ii. $\boldsymbol{\sin(x)=2[J_1-J_3+J_5-.....]}$

12. Using the Jacobi series , prove the following

    i. $J_n(x)=\frac{1}{\pi}\int_0^{\pi}\cos(n\theta-x\sin\theta)d\theta,\ n\ \text{being an intger}$

    ii. $J_0(x)=\frac{1}{\pi}\int_0^{\pi}\cos(x\cos\phi)\,d\phi$

    iii. $J_0^2+2J_1^2+2J_2^2+2J_3^2+.....=1$

UNIT III LAPLACE TRANSFORMS

1. Find the Laplace transform of following piecewise continuous functions:

   a) $f(t)=\begin{cases}4, & 0<t<1\\ 3, & t>1\end{cases}$ Ans: $\frac{1}{s}\left(4-e^{-s}\right)$

b) $f(t)=\begin{cases} t, & 0\le t<1 \\ 2-t, & 1\le t<2 \\ 0, & t\ge 2 \end{cases}$ Ans: $\frac{1}{s^2}\left(1-2e^{-s}+e^{-2s}\right)$

2. Find the Laplace Transforms of the following functions

i. $\sin 3t+t^2+e^{-2t}+t^{3/2}+5^t$ **Ans**: $\frac{3}{s^2+9}+\frac{2}{s^3}+\frac{1}{s+2}+\frac{3\sqrt{\pi}}{4}\frac{1}{s^{5/2}}+\frac{1}{s-\log 5}$

ii. $\sin 2t\cos 3t$ **Ans**: $\frac{1}{2}\left[\frac{5}{s^2+25}-\frac{1}{s^2+1}\right]$

iii. $\sin^3 2t$ **Ans**: $\frac{3}{2}\left[\frac{1}{s^2+4}-\frac{1}{s^2+36}\right]$

iv. $e^{-t}\sin^2 t$ **Ans**: $\frac{1}{2}\left[\frac{1}{s+1}-\frac{s}{s^2+4}\right]$

v. t^4e^{-t} **Ans**: $\frac{4!}{(s+1)^5}$

vi. $t\sin at$ **Ans**: $\frac{2as}{\left(s^2+a^2\right)^2}$

vii. $t^2e^{3t}\sin t$ **Ans**: $\frac{6(s-3)^2-2}{\left((s-3)^2+1\right)^3}$

viii. $t^3\sinh at$ **Ans**: $\frac{24as\left(s^2+a^2\right)}{\left(s^2-a^2\right)^4}$

ix. $\frac{e^{-t}\sin t}{t}$ **Ans**: $\cot^{-1}(s+1)$

x. $\frac{t-\sinh at}{t}$ **Ans**: $\frac{1}{s}+\frac{1}{2}\log\left(\frac{s-a}{s+a}\right)$

xi. $\frac{1-\cos t}{t^2}$ **Ans**: $-s\log\left(1+\frac{1}{s^2}\right)2\cot^{-1}(s)$

xii. $\frac{e^{3t}-1}{t}$ **Ans**: $\log\left(\frac{s}{s-3}\right)$

3. If $L\left[\frac{\sin t}{t}\right]=\tan^{-1}\left(\frac{1}{s}\right)$, then what is $L\left[\frac{\sin 3t}{3t}\right]$?

4. Evaluate the following integrals using LT

i. $\int_0^\infty \frac{\sin^2 t}{t^2}dt$ **Ans**: $\frac{\pi}{2}$ ii. $\int_0^\infty e^{-3t}t\sin t\,dt$ **Ans**: $\frac{3}{50}$

iii. $\int_0^\infty \frac{e^{-\sqrt{2}t}\sinh t\,\sin t}{t}dt$ **Ans**: $\frac{\pi}{8}$ iv. $\int_0^\infty \frac{\cos 4t-\cos 5t}{t}dt$ **Ans**: $\log\frac{4}{5}$

5. Find the LP of the following integrals

i. $\int_0^t \frac{e^{-4t}\sin 3t}{t}dt$ **Ans**: $\frac{1}{s}\cot^{-1}\left(\frac{s+4}{3}\right)$

ii. $\int_0^t\int_0^t \frac{\sin^3 t}{t}dtdt$ **Ans**: $\frac{1}{s^2}\left[\frac{\pi}{4}-\frac{3}{4}\tan^{-1}(s)+\frac{1}{4}\tan^{-1}\left(\frac{s}{3}\right)\right]$

iii. $\cosh t\int_0^t e^t\cosh t\ dt$ **Ans**: $\frac{1}{2}\left[\frac{s-2}{(s-1)^2(s-3)}+\frac{s}{(s+1)^2(s-1)}\right]$

6. If $L[f(t)]=\log\left(\frac{s-1}{s+1}\right)$ then what is $L\left[e^{-t}\int_0^t f(t)dt\right]$?

7. Find the LP of the following functions

i. $(t-2)^2u(t-2)$ **Ans**: $\frac{6e^{-2s}}{s^4}$ ii. $\sin 3(t-1)H(t-1)$ **Ans**: $\frac{3e^{-s}}{s^2+9}$

iii. $e^{5t}u(t-6)$ **Ans**: $\frac{e^{30-6s}}{s-5}$ iv. $e^{-t}+\cos\pi(t-2)$ **Ans**: $\frac{1}{s+1}+e^{-2s}\frac{s}{s^2+\pi}$

v. $\sinh 3t\,\delta(t-2)$ **Ans**: $e^{-2s}\sinh 6$ vii. $\sin 3t\,\delta\left(t-\frac{\pi}{2}\right)$ **Ans**: $-e^{-\pi s/2}$

8. Express the following functions in terms unit step function and hence find their LT

a) $f(t)=\begin{cases}4 & for\ 0<t<3\\ 2t+1 & for\ 3<t\end{cases}$ **Ans**: $\frac{4}{s}+\frac{3e^{-3s}}{s}+\frac{2e^{-3s}}{s^2}$

b) $f(t)=\begin{cases}6 & for\ 0<t<1\\ 8-2t & for\ 1<t<3\\ 4 & for\ t>3\end{cases}$ **Ans**: $\frac{6}{s}-\frac{2e^{-s}}{s^2}+\frac{2e^{-3s}}{s^2}+\frac{2e^{-3s}}{s}$

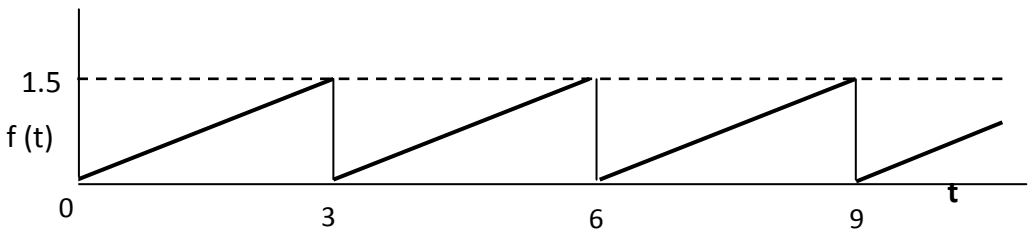
i. Find the LT of the following periodic functions

i. Half-wave rectifier output waveform

$$f(t)=\begin{cases}8\sin t, & 0<t<\pi\\ 0, & \pi<t>2\pi\end{cases}\quad with\ f(t+2\pi)=f(t)$$

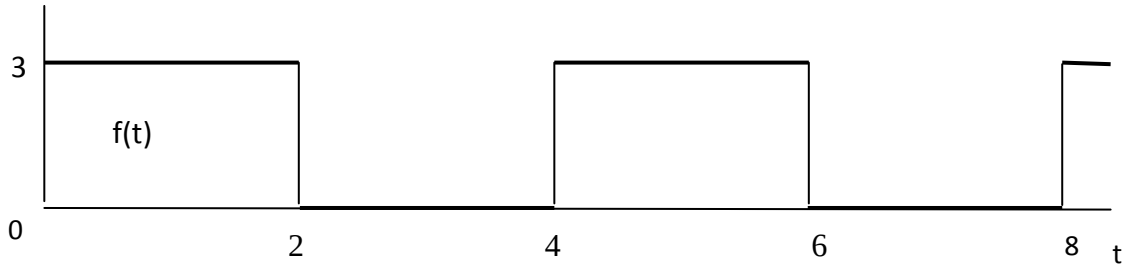
Ans: $\frac{8}{(1-e^{-\pi s})(s^2+1)}$

ii. $f(t)$ is given by following diagram



Ans: $\frac{1}{2s^2}\left[1-\frac{3s}{e^{3s}-1}\right]$

i. $f(t)$ is given by following diagram



Ans: $\frac{3}{s\left(1+e^{-2s}\right)}$

UNIT –IV INVERSE LAPLACE TRANSFORMS

1. Find the inverse Laplace Transform of the following functions

i. $\frac{1}{s+3}+\frac{1}{s^2+4}+\frac{1}{s^4}+\frac{1}{s^{3/2}}+\frac{4}{3s-2}+\frac{1}{(s-3)^3}$ **, Ans**:

$e^{-3t}+\frac{1}{2}\sin 2t+\frac{t^3}{3!}+2\sqrt{\frac{t}{\pi}}+\frac{4}{3}e^{-(2/3)t}+\frac{e^{3t}t^2}{2}$

ii. $\frac{s+2}{s^2-2s+5}$ **Ans**: $e^t\cos 2t+\frac{3}{4}e^t\sin 2t$ iii. $\frac{s+5}{s^2-6s+13}$ **Ans**: $e^{3t}\left[\cos 2t+4\sin 2t\right]$

iv. $\frac{3}{s(s+2)^2}$ **Ans**: $\frac{3}{4}-\frac{3}{4}e^{-2t}-\frac{3}{2}e^{-2t}t$ v. $\frac{5s^2-4s-7}{(s-3)(s^2+4)}$ **Ans**:

$2e^{3t}+3\cos 2t+\frac{5}{2}\sin 2t$

vi. $\frac{s}{(s^2+16)^2}$ **Ans**: $\frac{1}{2}t\sin 2t$ vii. $\frac{5s+1}{s^2-s-12}$ **Ans**: $3e^{4t}+2e^{-3t}$

viii. $\frac{1}{s(s^2+4)}$ **Ans**: $-\frac{1}{4}(\cos 2t-1)$ ix. $\frac{s}{(s^4+s^2+1)}$ **Ans**: $\frac{2}{\sqrt{3}}\sin\left(\frac{\sqrt{3}}{2}t\right)\sinh\left(\frac{t}{2}\right)$

2. If $L\{f(t)\}=\frac{1}{s^2}\{3s+2e^{-2s}-2e^{-5s}\}$, determine $f(t)$.

Ans: $3u(t)+2(t-2)u(t-2)-2(t-5)u(t-5)$

3. If $L\{f(t)\}=\frac{e^{-3s}}{(s-2)^4}$, determine $f(t)$. **Ans**: $\frac{e^{2(t-3)}(t-3)^3u(t-3)}{6}$

4. If $L^{-1}\{F(s)\}=f(t)$ and $f(0)=0$, then what is $L^{-1}\{sF(s)\}$?

5. If $L^{-1}\{F(s)\} = f(t)$ then what is $L^{-1}\left\{\frac{F(s)}{s}\right\}$?

6. Evaluate a) $\int_0^4 e^{-3t}\delta(t-2)\,dt$ **Ans:** e^{-6}

   b) $\int_0^6 8\,\delta(t-2)\,dt$ **Ans:** 8

7. Find $L^{-1}\left[\frac{se^{-2s}}{s^2+8s+16}\right]$ **Ans:** $e^{-4(t-2)}\{1-4(t-4)\}u(t-2)$

8. Find Inverse LT of the following functions

   i. $\log\left(1+\frac{a^2}{s^2}\right)$ **Ans:** $\frac{2-2\cos at}{t}$ ii. $\log\left(\frac{s-a}{s-b}\right)$ **Ans:** $\frac{e^{bt}-e^{at}}{t}$

   iii. $\cot^{-1}(s-a)$ **Ans:** $\frac{e^{at}\sin t}{t}$ iv. $\sin^{-1}\left[\frac{2s}{1+s^2}\right]$ **Ans:** $-\frac{2\sin t}{t}$

9. Using convolution Theorem, find Inverse Laplace Transform of

   a) $\frac{1}{(s^2+a^2)^2}$ **Ans:** $\frac{1}{2a^2}\left[\frac{1}{a}\sin at - t\cos at\right]$

   b) $\frac{s+2}{(s^2+45+5)^2}$ **Ans:** $\frac{e^{-2t}t\sin t}{2}$ c) $\frac{s^2}{s^4-a^4}$ **Ans:** $\frac{\sinh at+\sin at}{2a}$

10. The equation of motion of a system is $\frac{d^2y}{dt^2}+5\frac{dy}{dt}+4y=3\delta(t-2)$ at $t=0, y=2$ *and* $\frac{dy}{dt}=-2$. Determine an expression for the displacement y in terms of t

    Ans: $y=e^{-t}\{2+e^2u(t-2)\}-e^8e^{-4t}u(t-2)$

11. An impulsive voltage E is applied at $t=0$ to a series circuit containing inductance L and capacitance C. Initially, the current and charge are zero. The current i at time t is given by $L\frac{di}{dt}+\frac{q}{c}=E\,\delta(t)$, where q is the instantaneous value of the charge on the capacitor. Since $i=\frac{dq}{dt}$, determine an expression for the current i in the circuit at time t.

    Ans: $i=\frac{E}{L}\cos\left(\frac{t}{\sqrt{LC}}\right)$

12. Solve : $\frac{d^2y}{dt^2}-2\frac{dy}{dt}+y=t\,\delta(t-1);\ y(0)=y'(0)=0$ **Ans:** $e^{(t-1)}(t-1)u(t-1)$

13. Solve: $\frac{d^2y}{dt^2}-\frac{dy}{dt}-2y=12u(t-\pi)\sin t;\ y(0)=1, y'(0)=-1$

Ans: $e^{-t}+u(t-\pi)\left[1.2\cos t-3.6\sin t+2e^{-t+\pi}-0.8e^{2t-2\pi}\right]$

UNIT – V FOURIER SERIES

1. Find the Fourier series of $f(x)=e^{-ax}\ \ (-\pi,\pi)$

Ans: $a_0=\frac{2\sinh a\pi}{\pi a},\ a_n=\frac{2a(-1)^n}{\pi(a^2+n^2)}\sinh a\pi,\ b_n=\frac{2n(-1)^n}{\pi(a^2+n^2)}\sinh a\pi$

2. Does f(x) = tan x posses a Fourier expansion?
3. Find the Fourier series for the function $f(x)=|\cos x|$ in $(-\pi,\pi)$

Ans: $a_0=\frac{4}{\pi}$, $a_n=\frac{4}{\pi}\frac{\cos\left(n\pi/2\right)}{1-n^2}$,

4. Find the Fourier series for the function $f(x)=\begin{cases}2-x, & 0\le x\le 4\\ x-6, & 4\le x\le 8\end{cases}$. Deduce that

$$\frac{\pi^2}{8}=\sum_{n=1}^{\infty}\frac{1}{(2n-1)^2}$$

Ans: $a_0=0,\ a_n=\frac{-8}{\pi n^2}\left[(-1)^n-1\right]$

5. Obtain the Fourier series for the function $f(x)=\begin{cases}-\pi, & -\pi\le x\le 0\\ x, & 0\le x\le\pi\end{cases}$. Deduce that

$$\frac{\pi^2}{8}=\sum_{n=1}^{\infty}\frac{1}{(2n-1)^2}$$

$$a_0=-\frac{\pi}{2},\ a_n=\frac{1}{\pi n^2}\left[(-1)^n-1\right], b_n=\frac{1}{n}\left[1-2(-1)^n\right],\ f(0)=\frac{1}{2}\left[f(0^+)+f(0^-)\right]=\frac{1}{2}[-\pi+0]=-\frac{\pi}{2}$$

6. Find the Fourier series of $f(x)=x\sin x$ in $(0,2\pi)$

Ans: $x\sin x=-1-\frac{1}{2}\cos x+2\sum_{n=2}^{\infty}\frac{1}{n^2-1}\cos nx+\pi\sin x$

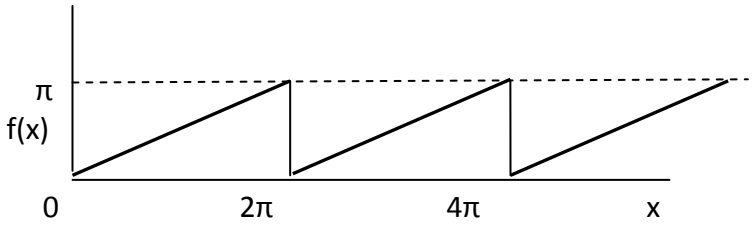
7. Find the Fourier series of $f(x)=\left(\frac{\pi-x}{2}\right)^2$ in $0<x<2\pi$. Hence deduce that

i. $\frac{\pi^2}{6}=\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^3}+\ldots\ldots$

ii. $\frac{\pi^2}{12}=\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^3}-\frac{1}{4^2}\ldots\ldots$

Ans: $f(x)=\frac{\pi^2}{12}+\sum_{n=1}^{\infty}\frac{\cos nx}{n^2}$

8. Determine the Fourier series to represent the periodic function shown



Ans: $f(x)=\frac{x}{2}\quad 0<x<2\pi,\quad a_0=\pi,\ a_n=0,\ b_n=-\frac{1}{n}$

9. Find the Fourier cosine series, the Fourier sine series. Write its two periodic extensions for the following functions

i. $f(x)=2-x\ \ (0<x<2)$

$$Ans:1+\frac{8}{\pi^2}\left(\cos\frac{\pi x}{2}+\frac{1}{9}\cos\frac{3\pi x}{2}+\frac{1}{25}\cos\frac{5\pi x}{2}+\ldots\right)$$
$$\frac{4}{\pi}\left(\sin\frac{\pi x}{2}+\frac{1}{2}\sin\pi x+\frac{1}{3}\sin\frac{3\pi x}{2}+\frac{1}{4}\sin 2\pi x\ldots\right)$$

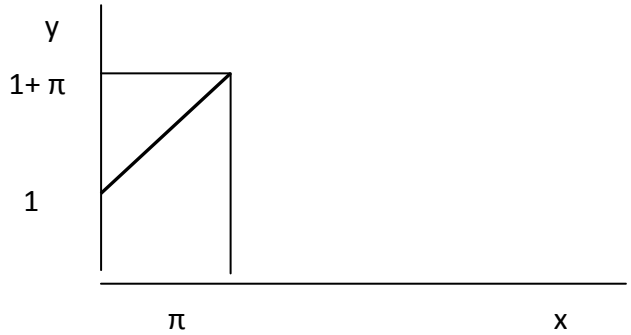
ii. $f(x)=x\ \ (0<x<L)$

$$Ans:\frac{L}{2}-\frac{4L}{\pi^2}\left(\cos\frac{\pi x}{L}+\frac{1}{9}\cos\frac{3\pi x}{L}+\frac{1}{25}\cos\frac{5\pi x}{L}+\ldots\right)$$
$$\frac{2L}{\pi}\left(\sin\frac{\pi x}{L}-\frac{1}{2}\sin\frac{2\pi x}{L}+\frac{1}{3}\sin\frac{3\pi x}{L}-+\ldots\right)$$

iii. $f(x)=\begin{cases}x, & 0<x<\pi/2\\ \pi/2, & \pi/2<x<\pi\end{cases}$

iv. $f(x)=x^2\ \ (0<x<L)$

v. $f(x)$ given by the graph



Ans: for sine series: $b_n = -\frac{2}{n}$, add extension $f(x) = (1-x)\ in\ (-\pi, 0)$

Problems on Parseval's formula

10. (a) Expand $f(x) = x,\ 0 < x < 2$ in a half range cosine series.

(b) Write the Parseval's identity corresponding to the Fourier series

(c) Determine from (b) the sum S of the series $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \ldots\ldots\ldots\ldots\ldots \frac{1}{n^4} + \ldots\ldots$

Ans: (a) $a_0 = 2, a_n = \frac{4}{n^2\pi^2}\left[(-1)^n - 1\right], b_n = 0$ (b) $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \ldots\ldots\ldots\ldots\ldots = \frac{\pi^4}{96}$

(c) $\frac{\pi^4}{90}$

11. Find the half range sine series for $f(x) = (\pi - x)^2,\ 0 \le x \le \pi$ and hence find the sum of the series $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \ldots\ldots\ldots\ldots\ldots$

Problems on Complex Fourier series

12. Find the complex Fourier series of $f(x) = e^x$ in $(-\pi, \pi)$ *and* $f(x + 2\pi) = f(x)$

Ans: $c_n = \frac{\sinh \pi}{\pi} \frac{1 + in}{(1 + n^2)} (-1)^n$

13. Find the complex form of $f(x) = \begin{cases} -1, & -\pi < x < 0 \\ 1, & 0 < x < \pi \end{cases}$

Ans: $f(x) = -\frac{2i}{\pi} \sum_{n=-\infty}^{\infty} \frac{1}{(2n+1)} e^{(2n+1)ix}$

14. Find the complex Fourier series of $f(x) = x$ in $(-\pi, \pi)$ *and* $f(x + 2\pi) = f(x)$

Ans: $f(x) = \pi + i \sum_{\substack{n=-\infty \\ n \neq 0}}^{\infty} \frac{1}{n} e^{inx}$

15. Find Fourier series of $f(x)$ up to the first harmonic using the given table :

x	0	π/3	2π/3	π	4π/3	5π/3	2π
f(x)	7.9	7.2	3.6	0.5	0.9	6.8	7.9

Ans: $4.4833 + 4.05\cos x + 0.8948 \sin x$

16. Find the Fourier series up to third harmonic and also find the amplitude of first harmonic from the following table

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

Ans: $\frac{41.666}{2} + (-8.333)\cos x + (-2.333)\cos 2x + (-2.337)\cos 3x + (-1.1547)\sin x + 0 + 0$

$Amplitude\ of\ \ first\ harmonic = \sqrt{a_1^{\,2} + b_1^{\,2}} = 8.4126$

17. Find a_0, a_1, a_2, a_3 in the Fourier cosine series for y which is tabulated below

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

Ans: $a_0 = 14,\ a_1 = -2.8,\ a_2 = -0.1,\ a_3 = 2.7$

UE19CS101: INTRODUCTION TO COMPUTING USING PYTHON (4-0-0-0-4)

LESSON PLAN **# of Hours: 52**

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			Reference Chapter	Cumulative
1.	**Introduction : Types, operators, expressions and control structures T1: 1.1 – 1.7 2.1 – 2.4 3.1 – 3.4**	Introduction- Computation Problem Solving - Limits of Computational Problem Solving Algorithms	44	44
2.		Computer Hardware - - - Operating System, Digital Computer - Limits of IC technology Computer Software - Syntax, semantics and program translation		
3.		Process of Computation Problem Solving - Analysis, Design, Implementation, Testing		
4.		Translation models Introduction to Python Programming Language Programming paradigms		
5.		First program in Python Program Structure Running a program		
6.		Output function, Variables, types and id		
7.		Input function		
8.		Problem solving using output functions & input functions		
9.		Operators and expressions		
10.		Precedence and Associativity		
11.		Control structures – selection and looping		
12.		Problem Solving using selection and looping		
13.		Concept of Library		
14.		Problem solving using different libraries		
15.	**Collections T1: 4.1 – 4.3, 4.4.1 9.1 – 9.2 8.3**	Lists & Tuples	20	64
16.		1. Operations on Lists and Tuples		
17.		Problem solving using Lists & Tuples		
18.		2. Dictionary & Sets		
19.		3. Operations on Dictionary & Sets		
20.		Problem solving using Dictionary & Sets		
21.		Strings		
22.		Operations on Strings		
23.		Problem solving using Strings		
24.	**Functions**	4. Functions – Definition, call, value returning functions and Non-value returning functions	10	74
25.		5. Nesting of functions		

26.	**T1 : 5.1 -5.2 11.1,**	Positional and keyword parameters, Default parameters,		
27.		variable number of arguments, key value pairs as arguments Recursion		
28.		Problem solving using functions		
29.		Recursion		
30.		Callbacks		
31.		6. Problem solving using Recursion and callback		
32.		7. Closures		
33.		Decorators		
34.		8. Problem solving using closures and decorators		
35.				
36.	**Functional Programming and Modules L1 T1: 4.4.2 7.1 – 7.3**	9. Functional programming - map, filter, reduce, max, min	13	87
37.		Lambda function		
38.		Problem solving on functional programming		
39.		List comprehensions		
40.		Modules - Import mechanisms, Usage of __doc__ , __name__ , __call__		
41.		10. Generators and iterators		
42.		11. Problem solving using generators and iterators		
43.	**Object Oriented Programming T1: 10.1 - 10.4, 8.1, 8.2, 8.4**	Object oriented programming features	13	100
44.		12. Python Classes and objects		
45.		Problem Solving on classes and objects		
46.		Exception & Types Exception handling constructs - try, except, else, finally and raise		
47.		Exception propagation and Problem solving		
48.		13. File processing- reading and writing files		
49.		Problem solving on file processing		
50.		Revision		
51.		Revision		
52.		Revision		
53-56		Revision Classes		

Question Bank

INTRODUCTION TO COMPUTING USING PYTHON - UE19CS101

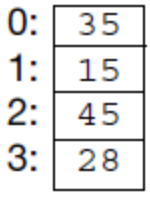
Questions – Unit 1

14.	For the Man, Cabbage, Goat, Wolf problem: (a) List all the invalid states for this problem, that is, in which the goat is left alone with the cabbage, or the wolf is left alone with the goat. (b) Give the shortest sequence of steps that solves the MCGW problem.

	(c) Give the sequence of state representations that correspond to your solution starting with (E,E,E,E) and ending with (W,W,W,W). (d) There is an alternate means of representing states. Rather than a sequence representation, a set representation can be used. In this representation, if an item is on the east side of the river, its symbol is in the set, and if on the west side, the symbol is not in the set as shown below, {M,C,G,W}—all items on east side of river (start state) {C,W}—cabbage and wolf on east side of river, man and goat on west side { }—all items on the west side of the river (goal state) Give the sequence of states for your solution to the problem using this new state representation. (e) How many shortest solutions are there for this problem?
15.	Show all steps for determining the day of the week for January 24, 2018. (Note that 2018 is not a leap year.)
16.	What is the number of bits in 8 bytes, assuming the usual number of bits in a byte?
17.	Assuming that Moore's Law continues to hold true, where n is the number of transistors that can currently be placed on an integrated circuit (chip), and k*n is the number that can be placed on a chip in eight years, what is the value of k?
18.	List any two applications of programming languages.
19.	List the Benefits of compiler and interpreter
20.	Explain the phases involved in the process of Computational Problem Solving.
21.	Briefly explain the three major components of an IDE?
22.	Given the code in code.py, how do you execute it in command prompt?
23.	Use the Python Interactive Shell to calculate the number of routes that can be taken for the Traveling Salesman problem for: (a) 6 cities (b) 12 cities (c) 18 cities (d) 36 cities
24.	Which of the following is a proper arithmetic expression in Python? (a) 10(15+6) (b) (10 * 2)(4+8) (c) 5 * (6 - 2)
25.	Exactly what is output by the following if the user enters 24 in response to the input prompt. age = input('How old are you?: ') print('You are', age, 'years old')
26.	Write a simple Python program that displays the following powers of 2, one per line: 2^1, 2^2, 2^3, 2^4, 2^5, 2^6.
27.	Write a Python program that allows the user to enter a four-digit binary number and displays its value in base 10. Each binary digit should be entered one per line, starting with the leftmost digit, as shown below. Enter leftmost digit: 1 Enter the next digit: 0 Enter the next digit: 0 Enter the next digit: 1 The value is 9
28.	Write a program to find the area of a circle where in , the radius is entered by the user. Hint: Use math module

29.	Write a program to print today's date, month and year in a separate line. Hint: Use datetime module
30.	Print current time in the python prompt in this format(Hours – Minutes - Seconds). Hint: Use time module
31.	Write a Python program that prompts the user for two integer values and displays the result of the first number divided by the second, with exactly two decimal places displayed
32.	Write a Python program that prompts the user for two floating-point values and displays the result of the first number divided by the second, with exactly six decimal places displayed.
33.	Write a Python program that prompts the user for two fl oating-point values and displays the result of the first number divided by the second, with exactly six decimal places displayed in scientifi c notation.
34.	Write a Python program that prompts the user to enter an upper or lower case letter and displays the corresponding Unicode encoding.
35.	Write a code to convert from Celsius to Fahrenheit. The formula for the conversion is f = (c * 9/5)+32
36.	Give an appropriate Boolean expression for each of the following. (a) Determine if variable num is greater than or equal to 0, and less than 100. (b) Determine if variable num is less than 100 and greater than or equal to 0, or it is equal to 200. (c) Determine if either the name 'Thompson' or 'Wu' appears in a list of names assigned to variable last_names. (d) Determine if the name 'Thomson' appears and the name 'Wu' does not appear in a list of last names assigned to variable last_names.
37.	Evaluate the following Boolean expressions for num1 5 10 and num2 5 20. (a) not (num1 , 1) and num2 , 10 (b) not (num1 , 1) and num2 , 10 or num1 1 num3 , 100
38.	Write a code to multiply a series of integers input by the user, until a sentinel value of 0 is entered.
39.	Write a program containing a pair of nested while loops that displays the integer values 1–100, ten numbers per row, with the aligned columns
40.	Write a Python Program to Display the multiplication Table
41.	Write a Python Program to Solve Quadratic Equation
42.	Use Python to find the number of minutes in a week.
43.	Function f is defined by f(x) = - 2 x 2 + 6 x - 3 . Substitute x by -2 in the formula of the function and calculate f(-2) as follows f(-2) = - 2 (-2) 2 + 6 (-2) - 3 f(-2) = -23 Write a code to implement the above functionality

Questions – Unit 2

1.	Which of the following would be the resulting list after inserting the value 50 at index 2? 

	(a) 0: 35, 1: 50, 2: 15, 3: 45, 4: 28 (b) 0: 35, 1: 15, 2: 50, 3: 45, 4: 28 (c) 0: 50, 1: 35, 2: 15, 3: 45, 4: 28
2.	Given the below list, print the alternate elements of the list. Numbers=[67,89,23,09,23,18,10,13]
3.	Given a list, write the code to replace the elements of the list with its square root.
4.	Create a list with n elements in it. Input n from the user. Include the code to check whether the list is a palindrome or not.
5.	Create a list with numbers between 0 and 9 in which the square of numbers are between 5 and 100.
6.	For a nested list lst that contains sublists of integers of the form [n1, n2, n3], (a) Give a Python instruction that determines the length of the list. (b) Give Python code that determines how many total integer values there are in list lst. (c) Give Python code that totals all the values in list lst. (d) Given an assignment statement that assigns the third integer of the fourth element (sublist) of lst to the value 12.
7.	For a list of integers named nums, (a) Write a while loop that adds up all the values in nums. (b) Write a for loop that adds up all the values in nums in which the loop variable is assigned each value in the list. (c) Write a for loop that adds up all the elements in nums in which the loop variable is assigned to the index value of each element in the list. (d) Write a for loop that displays the elements in nums backwards. (e) Write a for loop that displays every other element in nums, starting with the first element.
8.	Given two lists l1 and l2, create a new list by merging these two so that there is no repetition of elements in the new list and print the length of new list.
9.	Write a Python program that prompts the user to enter a list of words and stores in a list only those words whose first letter occurs again within the word (for example, 'Baboon'). The program should display the resulting list.
10	Write a Python program that prompts the user to enter types of fruit and how many pounds of fruit there are for each type. The program should then display the information in the form fruit , weight listed in alphabetical order, one fruit type per line as shown below, Apple, 6 lbs. Banana, 11 lbs.
11	Write a Python program that prompts the user to enter integer values for each of two lists. It then should displays whether the lists are of the same length, whether the elements in each list sum to the same value and whether there are any values that occur in both lists.

12	Write a program which will find all such numbers which are divisible by 7 but are not a multiple of 5, between 2000 and 3200 (both included). The numbers obtained should be printed in a comma-separated list on a single line.
13	Write a program which can compute the factorial of a given numbers. The results should be printed in a comma-separated sequence on a single line. Suppose the following input is supplied to the program: 5 Then, the output should be: [1,2,0]
14	Given a nested list, write a python code to flatten the nested list structure
15	Given a collection of three words in a list, create a new nested list with the Unicode values of each character in the word grouped together as an internal list. Suppose the given list is s1=[“world”,”Independence”] S2=[[119, 111, 114, 108, 100], [73, 110, 100, 101, 112, 101, 110, 100, 101, 110, 99, 101]]
16	Write a Python script that illustrates how to unpack a tuple into a list
17	Develop a Python program that allows a user to type in a message and have it converted into Morse code and also enter Morse code and have it converted back to the original message. 
18	Write a program which takes 2 digits, X,Y as input and generates a 2-dimensional array. The element value in the i-th row and j-th column of the array should be i*j. Note: i=0,1.., X-1; j=0,1,¡Y-1. Example Suppose the following inputs are given to the program: 3,5 Then, the output of the program should be:

	[[0, 0, 0, 0, 0], [0, 1, 2, 3, 4], [0, 2, 4, 6, 8]]
19	Write a program to sort the (name, age, height) tuples by ascending order where name is string, age and height are numbers. The tuples are input by console. The sort criteria is: 1: Sort based on name; 2: Then sort based on age; 3: Then sort by score. The priority is that name > age > score. If the following tuples are given as input to the program: Tom,19,80 John,20,90 Jony,17,91 Jony,17,93 Json,21,85 Then, the output of the program should be: [('John', '20', '90'), ('Jony', '17', '91'), ('Jony', '17', '93'), ('Json', '21', '85'), ('Tom', '19', '80')]
20	Given an n-tuple of single digit numbers such as (1,3,4,2), which represents a larger n-digit number, return that n-tuple "incremented" by one. Examples (1,3,4,2) -> (1,3,4,3), (9,9,9) -> (1, 0, 0, 0)
21	Generating a tuple containing only even numbers from another tuple
22	With a given integral number n, write a program to generate a dictionary that contains (i, i*i) such that is an integral number between 1 and n (both included). and then the program should print the dictionary. Suppose the following input is supplied to the program: 8 Then, the output should be: {1: 1, 2: 4, 3: 9, 4: 16, 5: 25, 6: 36, 7: 49, 8: 64}
23	Define two lists by taking 4 elements from the user for each list. Concatenate it and display it in the form of key-value pair
24	Given the list of words like phrase=[“Health”, “is”, “Wealth”] Create a new nested list in such a way that each internal list has an uppercase, lowercase and length of each word in the original list New_phrase = [[“health”,”HEALTH”,6],[“is”,”IS”,2][“wealth”,”WEALTH”,6]]
25	With two given lists [1,3,6,78,35,55] and [12,24,35,24,88,120,155], write a program to make a list whose elements are intersection of the above given lists.
26	With a given list [12,24,35,24,88,120,155,88,120,155], write a program to print this list after removing all duplicate values with original order reserved
27	Create an empty dictionary. Update the dictionary with n student’s name and cgpa. Print the cgpa

	of student whose name is entered in the console.
28	Write a Python Program to Multiply Two Matrices
29	Write a program that will store the schedule for a given day for a particular TV station. The program should ask you for the name of the station and the day of the week before asking you for the name of each show and the start and stop times. Once the schedule is complete it should be displayed as a table.
30	Create another version of the Hangman game, this time using Lists. The program should ask for the word to guess and the number of chances to be given. It should then split the characters in the word into individual items in a list. The other player should then be allowed to guess characters in the word. The program should display correctly guessed characters and unknown characters in the same way as the previous Hangman game.

Questions – Unit 3

1.	Write a function which takes name as a string parameter and prints "Hi" with the passed String. Test this function only if it is a main module.
2.	Write a program to collect the ASCII codes of all characters in a string in the form of list using functional programming constructs
3.	Write a Python Program to Remove Punctuations From a String
4.	Write a Python to Convert the Decimal number to Binary using Recursion
5.	Write an expression whose value is the average of the elements of the list [20, 10, 15, 75].
6.	Hamming distance is the number of positions at which the corresponding symbols are different. It's defined for two strings of equal length. Write a function hamming which takes two parameters and returns the sum of positions at which the symbols are different. Output is : print(hamming('toned', 'roses')) # 3 print(hamming('2173896', '2233796')) # 3 print(hamming('0100101000', '1101010100')) # 6
7.	Write a function which takes year as an input and check whether it is a leap year or not.
8.	Write a double list comprehension over the lists ['A','B','C'] and [1,2,3] whose value is the list of all possible two-element lists [letter, number]. That is, the value is [['A', 1], ['A', 2], ['A', 3], ['B', 1], ['B', 2],['B', 3], ['C', 1], ['C', 2], ['C', 3]]
9.	Write a comprehension over {1,2,3,4,5} whose value is the set consisting of the squares of the first five positive integers.
10	Write a Python Program to display the powers of 2 using Anonymous Function
11	Write a function char_freq() that takes a string and builds a frequency listing of the characters contained in it. Represent the frequency listing as a Python dictionary. Try it with something like char_freq("abbabcbdbabdbdbababababcbcbab")
12	A pangram is a sentence that contains all the letters of the English alphabet at least once, for example: The quick brown fox jumps over the lazy dog. Your task here is to write a function to check a sentence to see if it is a pangram or not.

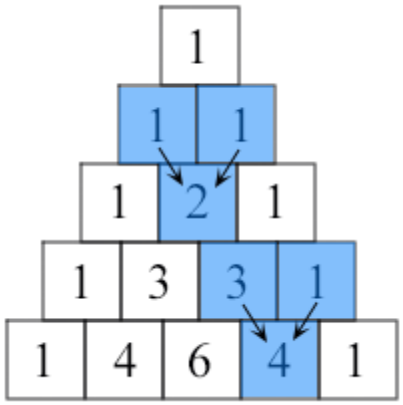
13	Write a Python function that accepts a string and calculate the number of upper case letters and lower case letters
14	Define a function max() that takes two numbers as arguments and returns the largest of them. Use the if-then-else construct available in Python. (It is true that Python has the max() function built in, but writing it yourself is nevertheless a good exercise.)
15	Write a function translate() that will translate a text into some pattern. For example, translate("this") should return the string “tothothiothiso”.
16	Define a function sum() and a function multiply() that sums and multiplies (respectively) all the numbers in a list of numbers. For example, sum([1, 2, 3, 4]) should return 10, and multiply([1, 2, 3, 4]) should return 24.
17	Define a procedure histogram() that takes a list of integers and prints a histogram to the screen. For example, histogram([4, 9, 7]) should print the following: **** ********* *******
18	Define a function overlapping() that takes two lists and returns True if they have at least one member in common, False otherwise. You may use your is_member() function, or the in operator, but for the sake of the exercise, you should (also) write it using two nested for-loops.
19	A sentence splitter is a program capable of splitting a text into sentences. The standard set of heuristics for sentence splitting includes (but isn't limited to) the following rules: Sentence boundaries occur at one of "." (periods), "?" or "!", except that 53. Periods followed by whitespace followed by a lower case letter are not sentence boundaries. 54. Periods followed by a digit with no intervening whitespace are not sentence boundaries. 55. Periods followed by whitespace and then an upper case letter, but preceded by any of a short list of titles are not sentence boundaries. Sample titles include Mr., Mrs., Dr., and so on. 56. Periods internal to a sequence of letters with no adjacent whitespace are not sentence boundaries (for example, www.aptex.com, or e.g). 57. Periods followed by certain kinds of punctuation (notably comma and more periods) are probably not sentence boundaries. Test your program with the following short text(This is the input string entered by the user): Mr. Smith bought cheapsite.com for 1.5 million dollars, i.e. he paid a lot for it. Did he mind? Adam Jones Jr. thinks he didn't. In any case, this isn't true... Well, with a probability of .9 it isn't. The result should be: Mr. Smith bought cheapsite.com for 1.5 million dollars, i.e. he paid a lot for it. Did he mind? Adam Jones Jr. thinks he didn't. In any case, this isn't true... Well, with a probability of .9 it isn't.
20	Your task in this exercise is as follows: a. Generate a string with N opening brackets ("[") and N closing brackets ("]"), in some arbitrary order. b. Determine whether the generated string is *balanced*; that is, whether it consists entirely

	of pairs of opening/closing brackets (in that order), none of which mis-nest. Examples: [] OK][NOT OK [][] OK][][NOT OK [[][]] OK [][][] NOT OK
21	Write a Python program to make a chain of function decorators (bold, italic, underline etc.) in Python
22	(A) Suppose S is a set of integers, e.g. {-4, -2, 1, 2, 5, 0}. Write a triple comprehension whose value is a list of all three-element tuples (i, j, k) such that i, j, k are elements of S whose sum is zero. (B) Modify the comprehension of the previous task so that the resulting list does not include (0,0,0).
23	Using range, write a comprehension whose value is a dictionary. The keys should be the integers from 0 to 99 and the value corresponding to a key should be the square of the key.
24	Assign some set to the variable D, e.g. D ={'red','white','blue'}. Now write a comprehension that evaluates to a dictionary that represents the identity function on D.
25	Design a module to input two numbers from the user and an operator. Use this module in the main module to perform all arithmetic operations on these two numbers based on the entered operator.
26	Write a function that will enable you to create and store quiz questions with multiple choice answers and then allow someone else to take the quiz.
27	Write a function named calculateAge that: takes 2 arguments: birth year, current year. calculates the 2 possible ages based on those years. outputs the result to the screen like so: "You are either NN or NN" Call the function three times with different sets of values. Hint: Figure out how to get the current year in JavaScript instead of passing it in
28	Create 2 functions that calculate properties of a circle, using the definitions here. Create a function called calcCircumfrence: Pass the radius to the function. Calculate the circumference based on the radius, and output "The circumference is NN". Create a function called calcArea: Pass the radius to the function. Calculate the area based on the radius, and output "The area is NN".
29	Ever wonder how much a "lifetime supply" of your favorite snack is? Wonder no more! Write a function named calculateSupply that: takes 2 arguments: age, amount per day. calculates the amount consumed for rest of the life (based on a constant max age). outputs the result to the screen like so: "You will need NN to last you until the ripe old age of X" Call that function three times, passing in different values each time. Hint: Accept floating point values for amount per day, and round the result to a round number.

30	Create a game of Connect 4 for two players. Assume that there can only be vertical and horizontal wins. Diagonals are not allowed for the moment. Ignore any validation of moves - assuming no cheating!.

Questions – Unit 4

1.	Write a program that maps a list of words into a list of integers representing the lengths of the corresponding words.
2.	Write a function find_longest_word() that takes a list of words and returns the length of the longest one
3.	Write a function filter_long_words() that takes a list of words and an integer n and returns the list of words that are longer than n.
4.	A pangram is a sentence that contains all the letters of the English alphabet at least once, for example: The quick brown fox jumps over the lazy dog. Your task here is to write a function to check a sentence to see if it is a pangram or not.
5.	Define a simple "spelling correction" function correct() that takes a string and sees to it that 1) two or more occurrences of the space character is compressed into one, and 2) inserts an extra space after a period if the period is directly followed by a letter. E.g. correct ("This is very funny and cool. Indeed!") should return "This is very funny and cool. Indeed!" Tip: Use regular expressions!
6.	Using the higher order function reduce(), write a function max_in_list() that takes a list of numbers and returns the largest one.
7.	Using the higher order function filter(), define a function filter_long_words() that takes a list of words and an integer n and returns the list of words that are longer than n.
8.	Represent a Python dictionary in the following fashion {"merry":"god", "christmas":"jul", "and":"och", "happy":gott", "new":"nytt", "year":"år"} and use it to translate your Christmas cards from English into Swedish. Use the higher order function map() to write a function translate() that takes a list of English words and returns a list of Swedish word
9.	Write a Python function to check whether a number is perfect or not. In number theory, a perfect number is a positive integer that is equal to the sum of its proper positive divisors, that is, the sum of its positive divisors excluding the number itself (also known as its aliquot sum). Equivalently, a perfect number is a number that is half the sum of all of its positive divisors (including itself). Example : The first perfect number is 6, because 1, 2, and 3 are its proper positive divisors, and 1 + 2 + 3 = 6. Equivalently, the number 6 is equal to half the sum of all its positive divisors: (1 + 2 + 3 + 6) / 2 = 6. The next perfect number is 28 = 1 + 2 + 4 + 7 + 14. This is followed by the perfect numbers 496 and 8128.
10	Write a Python function that that prints out the first n rows of the Pascal's triangle.

	
11	Write a Python program that accepts a hyphen separated sequence of words as input and prints the words in a hyphen-separated sequence after sorting them alphabetically. Sample Items : green-red-yellow-black-white Expected Result : black-green-red-white-yellow
12	Explain about dir() and help() functions in detail. Explain the significance of __name__, __call__ and __class__
13	List the differences between def and lambda.
14	Write a program that maps a list of words into a list of integers representing the lengths of the correponding words. Write it in three different ways: 1) using a for-loop, 2) using the higher order function map(), and 3) using list comprehensions.
15	Write a function find_longest_word() that takes a list of words and returns the length of the longest one. Use higher order functions.

Questions – Unit 5

1.	Briefly explain the fundamental features of OOP.
2.	Which of the following is a special method for defining an operator in a class? (a) __init__ (b) __add (c) __add__
3.	Which of the following are special methods in Python? (a) Getter and setters (b) Method names that begin and end with two underscore characters (c) Methods that are part of any Python built-in type
4.	Create a class to represent city which contains a list of places to see. Provide methods to create the object with just the city name or with city name and places [stored as list]. Provide methods to add a place of visit, to remove place of visit, to display all places of visit
5.	Create a class to represent city which contains a list of places to see. Provide methods to create the object with just the city name or with city name and places [stored as list]. Provide methods to add

	a place of visit, to remove place of visit, to display all places of visit
6.	To open a file c:\scores.txt for appending data, we use a) outfile = open("c:\\scores.txt", "a") b) outfile = open("c:\\scores.txt", "rw") c) outfile = open(file = "c:\scores.txt", "w") d) outfile = open(file = "c:\\scores.txt", "w")
7.	Design a Person class so that a person's age is calculated for the first time when a new person instance is created. Add a display method to display person's name and address.

8.	Given the below code, Explain the differences between the attributes name, surname and profession, and what values they can have in different instances of this class.
	class Smith:
	surname = "Smith"
	profession = "smith"
	def __init__(self, name, profession=None):
	self.name = name
	if profession is not None:
	self.profession = profession

9.	Create a class called Numbers, which has a single class attribute called MULTIPLIER, and a costructor which takes the parameters x and y (these should all be numbers). a. Write a method called add which returns the sum of the attributes x and y. b. Write a class method called multiply, which takes a single number parameter a and returns the product of a and MULTIPLIER. c. Write a static method called subtract, which takes two number parameters, b and c, and returns b - c. d. Write a method called value which returns a tuple containing the values of x and y. Make this method into a property, and write a setter and a deleter for manipulating the values of x and y.
10.	Create an instance of the Person class from example 7. Use the dir function on the instance. Then use the dir function on the class. a. What happens if you call the __str__ method on the instance? Verify that you get the same result if you call the str function with the instance as a parameter. b. What is the type of the instance? c. What is the type of the class? d. Write a function which prints out the names and values of all the custom attributes of any object that is passed in as a parameter.
11.	Write a class for creating completely generic objects: its __init__ function should accept any number of keyword parameters, and set them on the object as attributes with the keys as names. Write a __str__ method for the class – the string it returns should include the name of the class and the values of all the object's custom instance attributes.
12.	Write a Python class to reverse a string word by word. Input string : 'hello .py' Expected Output : '.py hello'
13.	Write a Python class which has two methods get_String and print_String. get_String accept a string

	from the user and print_String print the string in upper case
14.	Write a Python class named Rectangle constructed by a length and width and a method which will compute the area of a rectangle.
15.	Write a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a circle.
16.	Write a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a circle
17.	Build a list containing the 5 filenames of the text files that are going to be used. Add a bogus file name that doesn't exist to the list (so that we have to do some error handling) . Loop over the list and for each file (Remember here that we have a non existent file in the list and calling open on this will result in an IOError exception that needs to be dealt with) 58. Open the file; 59. Loop over each line; 60. Split the line up into sections (Hint: The string has a .split() function that splits the string on whitespace and gives back a list with each section as an element of the list) 61. Convert the second column value into an float 62. Keep track of the values for each line and compute an average for the file. Finally, print out a list of file,average-value pairs
18.	Which function is used to read all the characters from the file? a) Read() b) Readcharacters() c) Readall() d) Readchar()
19.	Which function is used to write a list of string in a file a) writeline() b) writelines() c) writestatement() d) writefullline()
20.	Define a class called FruitShop. Object of this class is created with the name and price of the fruit. Add methods to find the costperkg for any fruit and total priceoforder. Add getters and setters. Test these methods using the client code
21.	Model a bank account with support for deposit and withdraw operations. Add a display method to print balance either after deposit or after withdraw. Create different accounts to test this class.
22.	Find all of the errors (syntax, run-time, and logic) in the program below: import Math radius = input("Enter the radius of a circle:) area = math.Pi * Radius*2

print "The area of the circle with radius", r 'is', area

23. Implement the body of the function specified in the box based on the specification given.

```
def findAll(wordList, lStr):
    """assumes: wordList is a list of words in lowercase.
                lStr is a str of lowercase letters.
                No letter occurs in lStr more than once
       returns: a list of all the words in wordList that conta
                each of the letters in lStr exactly once and n
                letters not in lStr."""
```

24. The following code does not meet its specification. Correct it.

```
def addVectors(v1, v2):
    """assumes v1 and v2 are lists of ints.
       Returns a list containing the pointwise sum of
       the elements in v1 and v2.  For example,
       addVectors([4,5], [1,2,3]) returns [5,7,3],and
       addVectors([], []) returns []. Does not modify inputs.
    if len(v1) > len(v2):
        result = v1
        other = v2
    else:
        result = v2
        other = v1
    for i in range(len(other)):
        result[i] += other[i]
    return result
```

25. Create a class called Numbers, which has a single class attribute called MULTIPLIER, and a costructor which takes the parameters x and y (these should all be numbers).

a. Write a method called add which returns the sum of the attributes x and y.
b. Write a class method called multiply, which takes a single number parameter a and returns the product of a and MULTIPLIER.
c. Write a static method called subtract, which takes two number parameters, b and c, and returns b - c.

Write a method called value which returns a tuple containing the values of x and y. Make this method into a property, and write a setter and a deleter for manipulating the values of x and y.

UE19CS151: PROBLEM SOLVING WITH C (4-0-0-0-4)
Lesson Plan

# of Hours: 52

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			Reference Chapter	Cumulative
1.	**Unit: I Counting**	Introduction	19.23	19.23
2.		First program in 'C'		
3.		Simple input/output		
4.		Variables, Types and Operators		
5.		Operators continued(l value, r value, order of evaluation of operators and operands, sequence point)		
6.		Control structures		
7.		Control structures		
8.		Control structures		
9.		Problem solving : counting		
10.		Problem solving : counting		
11.	**Unit: II Text processing and string manipulation structures**	Functions: declaration and definition	19.23	38.46
12.		Functions: return and parameter passing		
13.		Functions: recursion		
14.		Functions: concept of interface and implementation		
15.		Arrays and pointers		
16.		Array initialization, Traversal		
17.		Arrays and functions		
18.		strings		
19.		Problem solving: string matching		
20.		Problem solving: string matching		
21.	**Unit : III Prioritized Scheduling**	Multi - dimensional arrays	23	61.46
22.		Multi - dimensional arrays		
23.		**1.** Structures		
24.		**2.** Structures		
25.		Array of structures		
26.		Array of structures		
27.		Dynamic memory management		
28.		Dynamic memory management		
29.		Linked list		
30.		Linked list		
31.		Problem Solving: scheduling		
32.		Problem Solving: scheduling		
33.	**Unit: IV**	Searching	19.23	80.7
34.		**1.** Binary Search		
35.		**2.** Callback		

36.	**Sorting**	Callback		
37.		**1.** Array of pointers to structures		
38.		**2.** Array of pointers to structures		
39.		Union and bitfields		
40.		Union and bitfields		
41.		Problem Solving: sorting		
42.		Problem Solving: sorting		
43.	**Unit: V Portable Programming and Interfaces**	Storage class and qualifiers	19.3	100
44.		**1.** static (internal and external), auto, global		
45.		Files		
46.		Files		
47.		enum		
48.		Conditional compilation and pragma		
49.		Command line arguments		
50.		Environment variables		
51.		Project: portable program development		
52.		Project: portable program development		
53 - 56		Revision Classes		

Text Book

1. R.G. Dromey, "How to solve it by computer", Pearson, 2011
2. Brian Kernighan & Dennis Ritchie, *"The C Programming Language*", 2nd Edition, Prentice Hall PTR, 1988

Reference Books:

1. Peter van der Linden, "Expert C Programming; Deep C secrets".
2. Alan R Feuer, "The C puzzle Book".

Problem Solving with C

UE19CS151 Questions

1.	Display all prime numbers between two Intervals, 1 and 300
2.	Accept a month in digit from the user. Display the month in words. If number is not between 1 and 12, display message "Invalid Month". (Use 'switch')
3.	Write a c program to check given number is prime number or not.
4.	Write a c program to reverse any number.
5.	Write a c program to check given number is strong number or not.
6.	Write a c program to find out sum of digit of given number.

	i) using functions ii) using recursion
7.	Write a c program to check given number is palindrome number or not.
8.	Write a program to print this triangle: * ** *** **** ***** ****** ******* ******** ********* **********
9.	Write a program to find out how many of the numbers from 1 to 10 are greater than 3. (The answer, of course, should be 7.) Hint: Your program should have a loop which steps a variable (probably named i) over the 10 numbers. Inside the loop, if i is greater than 3, add one to a second variable which keeps track of the count. At the end of the program, after the loop has finished, print out the count.
10	Write a program to compute the average of the ten numbers 1, 4, 9, ..., 81, 100, that is, the average of the squares of the numbers from 1 to 10
11	Write a program to print the first 7 positive integers and their factorials
12	Write a program to print the first 10 Fibonacci numbers
13	Write a loop to call the multbytwo() function on the numbers 1-10. Compile your main function and the multbytwo() function as two source files, one function per file.
14	Write the set of statements inside a function shown below to print the character ch, n times. void printnchars(int ch, int n){}
15	The standard library contains a function, atoi, which takes a string (presumably a string of digits) and converts it to an integer. For example, atoi("123") would return the integer 123. Write a program which reads lines (using getline), converts each line to an integer using atoi, and computes the average of all the numbers read.
16	Write a C Program to Display the multiplication Table
17	Write a program to read a file as its input, one line at a time, and print each line backwards. To do the reversing, write a function to reverse to reverse a given string.

	int reverse(char line[], int len) { ... }
18	Write a short program to read two lines of text, and concatenate them using strcat. Since strcat concatenates in-place, you'll have to make sure you have enough memory to hold the concatenated copy. For now, use a char array which is twice as big as either of the arrays you use for reading the two lines. Use strcpy to copy the first string to the destination array, and strcat to append the second one.
19	Write functions that: a) print all even numbers between 0 and 40. b) print all the numbers between 1 and 100, with 10 numbers on each line. Use two for loops. All columns should be aligned. c) ask for a number that prints the number squared. This repeats until the 0 is entered.
20	Write a program that asks for a number. Then the program should print 1 through the given number on separate lines.
21	Accept any two strings from the user. Display whether both the strings are equal or not. (do not use standard functions.)
22	Create a structure to store the employee number, name, department and basic salary. Create a array of structure to accept and display the values of 10 employees.
23	Accept any string from the user. Convert case of the string to lower / upper using pointers. (if entered string is in lower case convert it to uppercase and vice versa.)
24	Consider the statement double ans = 18.0/squared(2+1); For each of the four versions of the function macro squared() below, write the corresponding value of ans . 1. #define squared(x) x*x 2. #define squared(x) (x*x) 3. #define squared(x) (x)*(x) 4. #define squared(x) ((x)*(x))
25	Write a program to print the following patterns: a) 1 1 2 1 2 3 1 2 3 4 1 2 3 4 5 b) 1 1 2 2 2 1 2 3 3 3 3

	1 2 3 4 4 4 4 4 1 2 3 4 5 5 5 5 5 5
26	Write a C program to check if a number is perfect number or not.
27	Write a program to solve quadratic equation.

28	For each of the following statements, explain why it is not correct, and fix it.
	(a) #include <stdio.h>;
	(b) int function(void arg1)
	{
	return arg1-1;
	}
	(c) #define MESSAGE = "Happy new year!"
	puts(MESSAGE);

29	Write a program which passes one dimension array to function.
30	Write a program which passes two dimension array to function.
31	Write a program which passes structure to function.
32	Write a program for Floyd's triangle.
33	Write a program to print Pascal triangle.
34	Write the pattern matching program in C to prompt the user for the name of the file to search in and a pattern to search for.
35	Write the pattern matching program in C to accept the pattern and file name from the command line
36	Write a c program to find out prime factor of given number.
37	Write a c program to find out NCR factor of given number.
38	Which of the following statements should be used to obtain a remainder after dividing 3.14 by 2.1 ? A) rem = 3.14 % 2.1; B) rem = modf(3.14, 2.1); C) rem = fmod(3.14, 2.1); D) Remainder cannot be obtain in floating point division.

39	How many times the while loop will get executed if a short int is 2 byte wide?
	#include<stdio.h>
	int main()
	{
	int j=1;
	while(j <= 255)
	{

	printf("%c %d\n", j, j);
	j++;
	}
	return 0;
	}
	A) Infinite times B) 255 times C) 256 times D) 254 times

40	What is the output of the below code?
	#include<stdio.h>
	int main()
	{
	unsigned int i = 65535; /* Assume 2 byte integer*/
	while(i++ != 0)
	printf("%d",++i);
	printf("\n");
	return 0;
	}
	A) Infinite loop B) 0 1 2 ... 65535
	C) 0 1 2 ... 32767 - 32766 -32765 -1 0 D) No output

41	#include<stdio.h>
	int main()
	{
	int i = 5;
	while(i-- >= 0)
	printf("%d,", i);
	i = 5;
	printf("\n");
	while(i-- >= 0)
	printf("%i,", i);
	while(i-- >= 0)
	printf("%d,", i);
	return 0;
	}
	What is the output of the above code?
	A)
	4, 3, 2, 1, 0, -1
	4, 3, 2, 1, 0, -1
	
	B)
	5, 4, 3, 2, 1, 0
	5, 4, 3, 2, 1, 0
	
	C)

	Error D) 5, 4, 3, 2, 1, 0 5, 4, 3, 2, 1, 0 5, 4, 3, 2, 1, 0

42	What will be the output of the program?
	#include<stdio.h>
	int main()
	{
	int i = 1;
	switch(i)
	{
	printf("Hello\n");
	case 1:
	printf("Hi\n");
	break;
	case 2:
	printf("\nBye\n");
	break;
	}
	return 0;
	}
	A) Hello
	Hi
	B) Hello
	Bye
	C) Hi
	D) Bye

43	What will be the output of the program?
	#include<stdio.h>
	int main()
	{
	int x, y, z;
	x=y=z=1;
	z = ++x || ++y && ++z;
	printf("x=%d, y=%d, z=%d\n", x, y, z);
	return 0;
	}
	A) x=2, y=1, z=1 B) x=2, y=2, z=1 C) x=2, y=2, z=2 D) x=1, y=2, z=1

44	Point out the error, if any in the program. #include<stdio.h>

	int main()
	{
	int a = 10, b;
	a >=5 ? b=100: b=200;
	printf("%d\n", b);
	return 0;
	}
	A) 100 B) 200 C) Error: L value required for b D) Garbage value

45	What is the output of the program
	#include<stdio.h>
	int main()
	{
	struct emp
	{
	char name[20];
	int age;
	float sal;
	};
	struct emp e = {"Tiger"};
	printf("%d, %f\n", e.age, e.sal);
	return 0;
	}
	A) 0, 0.000000 B) Garbage values C) Error D) None of above

46	Point out the error in the program
	#include<stdio.h>
	int main()
	{
	int a=10;
	void f();
	a = f();
	printf("%d\n", a);
	return 0;
	}
	void f()
	{
	printf("Hi");
	}
	A) Error: Not allowed assignment B) Error: Doesn't print anything
	C) No error D) None of above

47	What will be the output of the program? #include<stdio.h> #define str(x) #x

	#define Xstr(x) str(x)
	#define oper multiply
	int main()
	{
	char *opername = Xstr(oper);
	printf("%s\n", opername);
	return 0;
	}
	A) Error: in macro substitution B) Error: invalid reference 'x' in macro
	C) print 'multiply' D) No output

48	Write a c program to find out power of number.
49	Write a c program to add two numbers without using addition operator.
50	Write a c program to subtract two numbers without using subtraction operator.
51	Write a c program to find largest among three numbers using binary minus operator.
52	Write a c program to find largest among three numbers using conditional operator
53	Write a program to check whether the number is prime and Armstrong Number by making function
54	Write a C program to Check whether a number can be expressed as the sum of two prime number
55	Write a C program to Find the sum of natural numbers using recursion
56	Write a program to Calculate factorial of a number using recursion
57	Write a program to Find G.C.D using recursion
58	Accept a file name from the user. Display the contents of the file. Also add the entered string to the file.
59	a) Accept any number as a command line argument. Write a program to display the number in reverse order. b) Write a short note on enum
60	Write a program to Reverse a sentence using recursion
61	What is the output of the below code? main( ) { printf(3+ ”hello”); } A) lo B) hello C) hel D) llo E) None of these

62	Write the output of the following code.
	A) main( )
	{
	float a= 5, b= 2;
	int c;
	c = a %b;
	printf(“%d”,c);

	}
	B) main( )
	{
	int i= i= -1, j= -1, k= 0, l= 2, m;
	m= i++ && j++ && k++ || l++;
	printf("%d%d%d%d%d", i, j, k, l, m);
	}
	C) main( )
	{
	int a = 5, b= 6, c = 9, d;
	d = (a<b ? (a<b ? (a>c ? 1:2) : (c>b? 6:8));
	printf("%d ",d);
	}
	D) main( )
	{
	int i = 30;
	{
	int i =10;
	printf("%d ",i);
	}
	printf(%d", i);
	}

63	How to output \n on the screen?

64	Find the errors in the given code snippet.
	A) void main()
	{
	int const * p=5;
	printf("%d",++(*p));
	}
	B) main()
	{
	extern int i;
	i=20;
	printf("%d",i);
	}
	C) main()
	{
	char string[]="Hello World";
	display(string);
	}
	void display(char *string)

	{
	printf("%s",string); }
	D) #include‹stdio.h›
	main()
	{
	struct xx
	{
	int x=3;
	char name[]="hello";
	};
	struct xx *s;
	printf("%d",s->x);
	printf("%s",s->name);
	}

65	What is the output of the below code?
	#define square(x) x*x
	main()
	{
	int i;
	i = 64/square(4);
	printf("%d",i);
	}
	A) None B) 4 C) 64 D) Error E) 16

UE19CY101: ENGINEERING CHEMISTRY (4-0-0-0-4)
LESSON PLAN

Class No.	Portion to be covered	% of Portion covered
UNIT I : MOLECULAR SPECTROSCOPY		
1	Interaction of electromagnetic radiation with matter	15 %
2	Electromagnetic spectrum	
3	Born - Oppenheimer approximation, Beer- Lambert's law	
4	Microwave spectroscopy- diatomic rigid rotor model, energy level diagram and rotational spectrum	
5	IR spectroscopy- diatomic harmonic oscillator, energy level diagram and vibrational spectrum	
6	Introduction to anharmonic oscillator, energy level diagram and spectrum	
7	Electronic spectroscopy-Vibrational coarse structure (Progressions)	
8	Franck Condon Principle	
UNIT II : FREE ENERGY IN CHEMICAL EQUILIBRIA		
9	Chemical potential, Phase equilibria	38%
10	Introduction to important terminologies: phase, component and degree of freedom	
11	Statement of Gibb's phase rule, Derivation of Gibb's phase rule	
12	Phase diagram of one component system-water system, Condensed Phase rule	
13	Phase diagram of two-component system-Pb-Ag system, Pattinson's process	
14	Construction of phase diagram using cooling curves , Fe-C system	
15	Origin of electrode potential, cell potentials, Derivation of Nernst equation	
16	Types of electrodes- explanation with examples	
17	Reference electrodes – calomel electrode and silver-silver chloride electrode	
18	Concentration cells, types of concentration cells	
19	Ion selective electrode- definition and derivation of expression for electrode potential of an ion selective electrode	
20	Glass electrode- construction and working , determination of pH using glass electrode	
UNIT III : ENERGY STORAGE DEVICES		
21	Batteries: Components of a battery and working	58%

22	Battery characteristics	
23	Numericals, Modern batteries- Reserve battery (Mg-AgCl battery)	
24	Zinc Air battery , Lithium batteries- advantages and disadvantages	
25	Li-ion battery(LiCoO2)	
26	Fuel cells: Principle and working	
27	Hydrogen-Oxygen fuel cells- alkaline fuel cell	
28	Polymer membrane fuel cell and solid oxide fuel cell	
29	Application of fuel cell in Oxygen sensors ,efficiency of fuel cells	
30	Super capacitors, Ragone plot	
UNIT IV : CORROSION CHEMISTRY		
31	Introduction, Electrochemical theory of corrosion	77 %
32	Types of corrosion – Differential metal, Differential aeration,	
33	Pitting corrosion	
34	Stress corrosion (caustic embrittlement)	
35	Factors affecting rate of corrosion	
36	Corrosion control: Metal coating – Galvanizing and Tinning	
37	Inorganic Coating – Anodizing and Phosphating	
38	Corrosion inhibitors	
39	Cathodic protection – Sacrificial Anode and Impressed current method	
40	Anodic protection	
UNIT V: FUNCTIONAL MATERIALS AND GREEN CHEMISTRY		
41	Polymers -introduction, addition and condensation polymers	100%
42	Glass transition temperature, structure - property relationship	
43	Commercial Polymers: Synthesis, properties and applications of PMMA, Butyl Rubber	
44	Resins - Synthesis, properties and applications of epoxy resin	
45	Polymer Composites: Synthesis and applications of Kevlar and reinforced Kevlar composites	
46	Synthesis and applications of Carbon fibres and reinforced C-fibre composites	
47	Conducting polymers-example, types of doping, mechanism of conduction in polymers using polyaniline as example, applications of conducting polymers	

48	Number average molecular weight, Weight average molecular weight, viscosity average molecular weight	
49	Nanomaterials: Introduction, classification,	
50	size dependent properties: surface area, thermal properties, optical properties, electrical properties and magnetic properties	
51	Applications of nanomaterials	
52	Green Chemistry; Introduction Twelve principles of Green Chemistry with examples	
53-56	Revision classes	

Self study component:

1. CH_3OH-O_2 fuel cell , fuel cell based Breath Analyser, Hydrogen storage methods.
2. Nanoscalematerials : Fullerenes, carbon nanotubes, nanowires and dendrimers

Text Books:

1. Engineering Chemistry, Gadag, R.V. and Nityananda Shetty A., Third reprint,2011 I.K.International Publishing House, Chapter 1,2,3,4,7,9 and 10
2. Fundamentals of molecular spectroscopy, Banwell , McCash, Fifth edition, 2013 McGraw Hill Education (India) Private Limited, Chapter 1,2,3,6
3. Engineering Chemistry, Jain,P.C. and Monica Jain., Sixteenth edition,2017
4. Dhanpat Rai Publishing Company(P) Ltd. Chapter 6 and 35
5. Engineering Chemistry, second edition,2014, Wiley publications, Chapter 21

Reference book:

1. Industrial Electrochemistry, Pletcher, D. and Walsh, F.C., Second edition, Blackie Academic and Professional, 1993.
2. Atkins Physical Chemistry, Atkins and de Paula, Tenth edition, 2014 Oxford University Press.

QUESTION BANK

UNIT I: MOLECULAR SPECTROSCOPY

1. State the condition that needs to be met for a molecule to microwave active and IR active. State whether the following molecules are microwave and IR active. Justify. H2, H2O, HCl, CO2, OCS, N2, HF
2. A molecules absorbs microwave photon of wavelength 20 cm. Calculate the energy difference between the two energy levels in joule.(Ans:9.9×10^{-25} J)
3. What does microwave radiation do to a molecule? "Rotational energy levels of a molecule are quantized", Elaborate.
4. Calculate the reduced mass and moment of inertia of HCl if the bond length is 1.27Å. Atomic mass of hydrogen =1.008, Chlorine = 35.45, 1 amu =1.66×10^{-27} kg, h=6.6×10^{-34} Js, c = 3×10^{8} m s^{-1} , N=6.023×10^{23} mol^{-1} . (Ans: μ=1.627×10^{-27} kg, I= 2.624×10^{-47} kgm^2)
5. Calculate the rotational energy of ^{14}N and ^{16}O corresponding to J = 1 level in Joule and cm^{-1} assuming it to be rigid rotor. The atomic masses of ^{14}N and ^{16}O are 14.004 amu and 15.994 amu respectively and bond length is 115pm. (1 amu =1.66×10^{-27} kg)
6. An absorption corresponds to wave number 1 cm^{-1}. Calculate the energy change corresponding it.

7. State Beer- Lambert's law and write an expression for it. A 0.01 M solution of a compound transmits 20% of the radiation in a container with path length of 1.5 cm. Calculate the molar extinction coefficient of the compound. .(Ans:46.598 M^{-1} cm^{-1})
8. Derive an expression for moment of inertia of rigid rotor model of a diatomic molecule.
9. Draw the energy level diagram for a rigid rotor diatomic molecule upto J = 5. . What is the spacing between two consecutive lines in the spectrum?
10. Calculate the energy required in cm^{-1} for the molecule to move from J = 3 to J = 4 level if B = 10.93 cm^{-1}.
11. The measured first line in pure rotation spectra of ^{1}H ^{27}Al corresponds to 12.604 cm^{-1}. Atomic mass of hydrogen =1.008 amu, Aluminium = 26.1895 amu, 1 amu = 1.66 x 10^{-27} kg, h=6.6 x10^{-34} Js, c = 3 x 10^{8} m s^{-1}, N=6.023 x 10^{23} mol^{-1} . Calculate the value of moment of inertia and bond length of molecule.
12. Write an expression for allowed vibrational energy levels of simple harmonic oscillator model of diatomic molecule. Explain the terms. Draw energy level diagram and explain why only one line is seen in the spectrum.
13. Write an expression for allowed vibrational energy levels of anharmonic oscillator model of diatomic molecule. Explain the terms. Draw vibrational energy level diagram. What are the selection rules?
14. What do you understand by fundamental absorption, first and second overtone? Derive an expression for the same. The spectrum of HCl shows a very intense absorption at 2886 cm^{-1} , a weak one at 5668 cm^{-1} and a very weak one at 8347 cm^{-1} .
    i) Calculate the equilibrium frequency of the molecule and anharmonicity constant from the data given.
    ii) Why do real molecules 'not obey' harmonic oscillator model?
    iii) Using harmonic oscillator concept calculate the zero-point vibrational energy of HCl given that the force constant of HCl is 516 Nm^{-1}.
15. The force constant of CO is 1840 N/m. Calculate oscillation frequency and wave number in cm^{-1} (Gram atomic mass of carbon=12, O=16, c=3x10^{8} m/sec. (Ans: 6.402x10^{-13} s^{-1}, 2134 cm^{-1})
16. For a HBr molecule: i) Calculate the reduced mass and force constant in N/m, when it shows harmonic oscillations, if the vibrational spectrum of the molecule shows a single intense line at 2649 cm^{-1}. Ii) If the same molecule shows anharmonic oscillations, calculate the wave number of fundamental absorption and first overtone if the anharmonicity constant of the molecule is 0.017 and the equilibrium vibrational frequency is 2649 cm^{-1}.
17. Given: N=6.023 x 10^{23} mol^{-1}, c=3x10^{8} m/sec, 1 amu = 1.66 x 10^{-27} kg, Gram molar mass of hydrogen =1.0, Bromine is = 80.0, h=6.6 x10^{-34} Js.
18. What is anharmonic oscillator model? Draw Morse curve to represent the energy of a diatomic molecule. What does the curve tell us about the behaviour of real molecules.
19. State Franck Condon principle. For the following electronic transitions, draw the spectrum and state the condition when such a spectrum would be observed:
    (i) v" = 0 to v' = 2
    (ii) v"= 0 to v' = a level beyond dissociation energy of the molecule.
    (iii) v" = 0 to v' = 3
    (iv) v" = 0 to v' = 0

UNIT 2: FREE ENERGY IN CHEMICAL EQUILIBRIA

1. Define chemical potential.
2. Give example of an equilibrium system of
    i) 2- phase,
    ii) ii) 3- component,
    iii) iii) an invariant system

3. Calculate the degrees of freedom.
   i) Two partially miscible liquids in the absence of vapor.
   ii) A solution of a solid in a liquid in equilibrium with solvent vapor
4. Draw a labeled phase diagram of water system and calculate degree of freedom at triple point and on the vaporization curve.
5. Derive phase rule using thermodynamic principles.
6. In the one component water system why does the fusion curve have a negative slope?
7. What are the phases in equilibrium with each other on the meta stable curve in water system phase diagram?
8. What is reduced phase rule? Describe lead-silver system with a help of neat labeled diagram.
9. How is the eutectic point different from eutectoid point for Fe-C system? Mention the phases in equilibrium and calculate degree of freedom at these points.
10. What is desilverisation of lead?
11. What are cooling curves? How are they useful in construction of phase diagrams?
12. Using Nernst equation for the cell at 298K represented by the equation, Calculate the EMF Sn (s)/Sn^{2+}(0.15M)// Ag^{+}(0.3M)/Ag(s). The standard reduction potential of Sn & Ag is -0.14 V and 0.8V respectively.
13. Using thermodynamic principles derive an expression for electrode potential of a metal rod dipped in a solution of its own ions.
14. What is a concentration cell? Discuss two types of concentration cell and derive an expression for the emf of a concentration cell.
15. Write the cell representation of an electrolyte concentration cell using zinc – amalgam electrodes. Calculate the E_{cell} at 298 K, if the concentrations of zinc ions are 0.5M and 0.2M. Given the standard reduction potential values of Zinc is -0.76V, R= 8.314J/K/mol, F= 96500C/mol.
16. Give two examples of metal-insoluble salt –ion electrode. Write the reaction when it acts as anode. Write the corresponding Nernst equation.
17. Discuss different types of electrodes with examples. Give their Nernst equation also.
18. Define ion- selective electrode. Derive an expression for electrode potential of an ion-selective electrode.
19. Discuss the working and construction of a glass electrode.
20. Use the cell indicated to answer the following questions. Pt, H_2(p_{H2} = 2.5 atm)/H^{+}(0.5)//Fe^{3+}(0.02M),Fe^{2+}(0.5M)/Pt
    i) Write the balanced half cell and overall cell reaction
    ii) Calculate E^{o}cell and Ecell at 298K
    iii) Calculate the maximum useful work that can be obtained from this cell?
21. During potentiometric estimation of iron, a galvanic cell is formed which consists of Pt/Fe^{3+},Fe^{2+} electrode and a calomel electrode containing 4.5M KCl. (Given:E0Fe3+/Fe2+=0.771V;E0 of calomel electrode =0.281V, [Fe2+]=0.1M,[Fe3+]=0.01M)
    i) Write the overall cell reaction.
    ii) Calculate Eocell and Ecell at 298K.(Ans:0.490V, 0.4695 V)
22. Calculate emf of the following galvanic cell at 300 K. Cu(s) / Cu2+(0.001M)// Cu2+ (0.1M)/ Cu (s). (Ans: 0.595 V).
23. Calculate the potential of Zn-Hg electrode in which 80% Zn- Hg is in contact with Zn^{2+} ions of concentration 0.06 M. (Given E^{0}=-0.76V).
24. Describe how pH of a solution is determined using glass electrode.
25. The emf of a cell set up by combining glass electrode and a saturated calomel electrode at 298K was found to be 0.1069V when a buffer of pH value 4 was used. With a solution of unknown pH at the same temperature, the cell offered an emf of 0.157V.Give the cell representation. Calculate the pH of the solution.(Given ESCE= 0.2412V)

26. For the electrode, Cu-Hg/Cu^{2+} at 25^0C, calculate the electrode potential. Given E^0Cu^{2+}/Cu = 0.34V.
27. Calculate the electrode potential of chlorine electrode at 25^0 C, Pt/ Cl_2 (1 atm)/ Cl^- (0.2M) Given E^0 Cl_2/Cl^- = 1.36V.

UNIT III : ENERGY STORAGE DEVICES

1. Name the basic components of a battery and discuss its working as galvanic cell and electrolytic cell.
2. What are reserve batteries? Explain the working with an example.
3. Why does zinc air battery have high energy density? Calculate Capacity, energy density (in J/Kg), Power density (in W/Kg), of the battery if 90g of Zinc is used and the battery lasts for 12000 mins. The battery weighs 120g and gives steady voltage of 1.4V. (Given: F=96000C/mol, molar mass of Zn =65g)
4. What are super capacitors? Mention two reasons why they have high capacity.
5. List the components of Zinc-air battery and discuss its working.
6. What are fuel cells? Give the construction of H2-O2 fuel cell with alkaline electrolyte. Mention one advantage of this fuel cell.
7. With the help of a neat diagram, explain the construction and working of polymer membrane electrolyte H2-O2 fuel cell. Why is water management important for this fuel cell?
8. Write the reactions which take place during the discharging of H2-O2 fuel cell which uses solid-oxide as electrolyte. Give an application of this fuel cell. Calculate the % efficiency of H2-O2 fuel cell, if the cell potential is 1.13 V and enthalpy of formation of water is -285.83 KJ. (Ans: 76.3 %).
9. Why are lithium batteries very popular? Give construction and working of lithium ion battery.
10. Discuss the following battery characteristics: Cycle life, Voltage, Capacity, Energy density, Electricity storage density.
11. How is a fuel cell different from a battery?
12. What is Ragone plot? Indicate fuel cells and super capacitors on this plot.
13. Discuss the construction of an oxygen sensor. Why the voltage is different for lean and rich mixture? Justify the use of solid-oxide electrolyte in Oxygen sensors.
14. Why Lithium ion battery is safer than lithium battery? Give the reason for high electricity storage density of lithium batteries.
15. Calculate E.S.D (in Ah/Kg) of a lithium battery which stores 1.5g of Li. The total weight of the battery is 50.45g. (Ans: 113.85 Ah/Kg)

UNIT IV : CORROSION CHEMISTRY

1. Define corrosion of a metal. Why do metals get corroded?
2. Explain electrochemical theory of corrosion taking iron as an example.
3. Identify the type of corrosion taking place in the following cases:
   (a) A small part of coating is peeled off on a tin coated iron surface
   (b) A nail pulled from the wall
   (c) Zn-Fe couple exposed to an aqueous environment
   (d) A bent steel rod exposed to a corrosive environment
4. Describe the following types of corrosion with an example
   (a) Differential metal corrosion (b) Waterline corrosion
5. Write the representation of the corrosion cell formed due to caustic embrittlement in boilers.
6. Write the various reactions which lead to the formation of the cell and explain.
7. Explain how the following factors affect corrosion:
   (a) Polarisation (b) Overvoltage (c) Nature of corrosion product (d) pH of the medium (e) Ratio of anodic to cathodic area
8. What are corrosion inhibitors? Name two cathodic inhibitors which reduce the concentration of oxygen in the environment around a metal.

9. Pitting corrosion is the most destructive type of corrosion. Discuss.
10. Describe impressed current method used for cathodic protection. Mention two disadvantages.
11. What is anodic protection? Explain impressed anodic current method of corrosion control.
12. Explain the process of anodizing. What type of metals can be anodized?
13. What is anodic metal coating? Describe galvanization process.
14. What corrosion control methods would you use for:
    (i) A ship sailing in the sea.
    (ii) Mild steel steam boiler
    (iii) Containers used for storing food.
15. Discuss the type of corrosion taking place in the following cases: a) Gaps on the surface of a tinned iron sheet b) Brass article exposed to ammonia cal vapors.
16. Why galvanized articles cannot be used to store food items?
17. What is anodic protection? Draw potential-current curve used to explain active-passive transitions of metals.
18. Explain how hydrogen overvoltage affects corrosion. How does As_2O_3 work as a corrosion inhibitor?
19. A Magnesium bar is attached to an iron pipeline:
    (i) Name the type of corrosion taking place
    (ii) Explain the suitable method of protection being used here.

UNIT V: FUNCTIONAL MATERIALS AND GREEN CHEMISTRY

1. Give examples of bi- and tri – functional monomers.
2. Give an example for addition and condensation polymerization reaction and list out few differences between addition and condensation polymerization.
3. Give the synthesis and applications of the following: (a)Epoxy resin (b)Plexiglass
4. Determine number average molecular weight, weight average molecular weight and viscosity average molecular weight of a polymer with 25 molecules having molar mass of 3000 and 50 molecules having molar mass of 2000 and 40 molecules having molar mass of 5000. (a=0.65). (Ans: 3260, 3800 and 3711).
5. What are conducting Polymers? What are the salient features required for a polymer to be conducting?
6. How is epoxy resin cured?
7. Write the structure of Kevlar. Explain why Kevlar is five times stronger than steel on equal weight basis. Give its synthesis.
8. Explain how the structure of the polymer affects its crystallinity.
9. What are plasticisers? Give an example.
10. Differentiate between thermoplastics and thermosetting plastics. Give one example each.
11. How is Butyl rubber synthesized? What are the conditions required for synthesizing butyl rubber?
12. How is Carbon fibre made from PAN (Polyacrylonitrile)? Mention two uses of Carbon fibre reinforced polymers.
13. Explain twelve principles of green chemistry with an example for each.
14. Define nanomaterials. Write two applications of nanomaterials.
15. Write a note on the optical properties exhibited by nanomaterials.
16. In what way the following will influence the size dependent properties of nano particles?

UE19CV101: Engineering Mechanics – Statics (3-0-0-0-3)

LESSON PLAN

No. of Hours: 42

Class	Chapter Title/ Reference Literature	Portions to be Covered	% Portions Covered	
			Referred Chapter	Cumulative
1 - 3	**UNIT 1**	Mechanics, Basic Concepts, Definitions Scalars and Vectors. Force systems - Introduction, Force	12%	12%
4 - 9		Rectangular Components, Moment,& Couple, Numerical problems	13%	25%
10-11	**UNIT 2**	**Equilibrium:** Introduction, Equilibrium in Two Dimensions, System Isolation and the Free-Body Diagram, Equilibrium conditions.	10%	35%
12 – 18		Numerical problems on equilibrium	7%	42%
19	**UNIT 3**	**Distributed Forces:** Centroids of Composite Bodies and figures.	5%	47%
20-21		Problems on centroid determination of simple areas and composite areas	5%	52%
22-24		**Area Moments of Inertia:** Introduction, Definitions, Composite areas.	6%	58%
25-26		Numerical problems on MI of composite areas	5%	63%
27	**UNIT 4**	**Structures:** Introduction, Plane Trusses, Method of Joints.	6%	69%
28-30		Numerical problems, Revision	6%	75%
31-35		**Beams** External effects, Numerical problems.	9%	84%
36	**UNIT 5**	**Friction:** Introduction, Frictional Phenomena, Types of Friction	2%	88%
37		Flexible flat belts	7%	96%
38-42		Numerical Problems, Revision	7%	100%

Reference Book:

1. "Engineering Mechanics Statics" J.L. Meriam, L.G. Kraige, J.N.Bolton, 8th edition, Wiley India, 2018

SYLLABUS FLOW FROM ENGINEERING MECHANICS STATICS, VOL 1, SI VERSION, J L MERIAM , L G KRAIGE AND J.N.BOLTON

UNIT I CHAPTER 1: 1/1, 1/2, 1/3 CHAPTER 2: 2/1, 2/2, 2/3, 2/4, 2/5, 2/6 Numerical problems.	**UNIT IV** CHAPTER 4: 4/1, 4/2, 4/3 CHAPTER 5: 5/6 Numerical Problems
UNIT II CHAPTER 3: 3/1, 3/2, 3/3 Numerical problems.	**UNIT V** CHAPTER 6: 6/1, 6/2, 6/3, 6/8 Numerical problems.
UNIT III CHAPTER 5: 5/1, Sec A - 5/3, 5/4 Appendix A: A/1-A/3 Numerical problems.	

NUMERICAL PROBLEMS

UNIT I:
CHAPTER 1: Problem No. 2/1 to 2/78

UNIT II:
CHAPTER 3: Problem No. 3/1 to 3/40.

UNIT III:
CHAPTER 5: Problem No. 5/47 to 5/59
- **Excluding** 5/54.

ANNEXURE A: Problem No. A/1 to A/19 and A/35 to A/49
B. **Excluding** A/5, A/8, A/10, A/11, A/13, A/15, A/47.

UNIT IV:
CHAPTER 4: Problem No. 4/1 to 4/19

CHAPTER 5: Problem No. 5/101 to 5/111, 5/116, 5/122
- **Excluding** 5/108,

UNIT V:
CHAPTER 6: Problem No. 6/97 to 6/109.

THEORY QUESTION BANK

UNIT I
INTRODUCTION TO STATICS

1. Explain the terms
   a. Space, b. Time, c. Mass, d. Force, e. Particle f. Rigid body
2. Explain the difference between Scalars and Vectors
3. Explain the terms
   a. Fixed Vector b. Sliding Vector c. Free Vector

FORCES

4. Explain the terms (with sketches)
   a. Coplanar Forces b. Concurrent Forces c. Collinear Forces
5. What are (Explain with sketches)
   a. Rectangular Components of a force b. Components of a force
   b. Projections of a force
6. Explain the Transmissibility of a force with a neat sketch
7. Define Force and state its characteristics

MOMENT

8. Explain the term Moment of a force with neat sketch
9. State and prove the Varignon's theorem/Principle of Moments

COUPLE

10. What is a Couple?
11. Define the term Couple and state its characteristics
12. Explain the term "Force-Couple System" with the help of neat sketch

UNIT II EQUILIBRIUM

13. Define the term Equilibrium
14. State and explain the conditions of equilibrium required for a system of coplanar, concurrent forces
15. State and explain the conditions of equilibrium required for a system of coplanar, non- concurrent forces

16. Explain the difference between statically determinacy and statically indeterminacy of a structure
17. What is meant by Free Body Diagram and why are they important?
18. What do you understand by the terms “Roller Support”, “Hinge support” and “Fixed Support”.

UNIT III

CENTROID

19. Distinguish between Centroid, Centre of Mass and Centre of Gravity
20. Determine the Centroid for an “ area of a circular sector”
21. Determine the Centroid distance of a triangle of base width, b, and height, h, from its base.

MOMENT OF INERTIA

22. Explain with a neat sketch the moment of inertia of a plane lamina about X, Y and polar axis
23. What is radius of gyration?
24. State and prove the parallel axis theorem
25. Determine the moment of inertia of a rectangular area about its centroidal X, Y and polar Z axis
26. Determine the moment of inertia of a triangle about an axis passing through its base, centroid and its vertex
27. Determine the moment of inertia of a circle about its centroidal X, Y and Z axis

UNIT IV

BEAMS

28. What are the different types of beams? Explain with sketches
29. Differentiate between statically determinant and statically in-determinant beam
30. Explain the different types of loadings on a beam

TRUSSES

31. Explain the terms internal redundancy and external redundancy as applied to trusses
32. What do you understand by m+3 = 2j in case of a truss? What are implications if this equation is not satisfied?

UNIT V FRICTION

33. What are the types of friction, briefly explain them
34. Derive an expression for Belt Friction

UE19EC101: FOUNDATION IN ELECTRONIC CIRCUITS AND SYSTEMS (3-0-0-0-3)

Lesson Plan

Hours: 42

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portion Covered	
			Individual	Cumulative
UNIT-1				
1-7	**Introduction to Electronics and semiconductor diodes**	Semiconductor diode under forward and reverse bias	16.66	16.66
		Shockley's equation		
		Zener and Avalanche breakdown, temperature effects		
		Ideal versus Practical diode, Diode resistances		
		Diode equivalent circuits, Zener diode characteristics		
		Series diode configurations		
		Problems		
UNIT-2				
8-16	**Semiconductor diode applications**	Block diagram of regulated power supply	21.42	38.09
		Half-wave rectifier: V_{dc},I_{dc}		
		Full-wave (center trap) rectifier: V_{dc},I_{dc}		
		Bridge rectifier: V_{dc},I_{dc}		
		ripple factor derivations, Peak inverse voltage		
		Shunt capacitor filter-working, output waveform and ripple factor equation		
		Zener diode voltage regulator		
		Problems on rectifier circuits		
		Problems on zener regulator		
UNIT-3				
17-26	**Digital Electronics**	Boolean Algebra and Logic gates: AND,OR,NOT,NAND,NOR	23.8	61.90
		Basic Theorem and Properties of Boolean Algebra		
		Boolean Functions, Canonical and Standard Form		
		Problems on Boolean algebra		
		Other Digital Logic gates: XOR,XNOR		
		Realization of Boolean expression using Universal Gates		
		Half Adder and Full adder		
		Multiplexer(2:1) and Demultiplexer (1:2)		
		Flip-Flops-SR, JK, D,T : Using Nand gates only		
		Sequential circuits :Registers: and counters		
UNIT-4				
27-36	**Transistors**	Transistor construction, transistor operation	23.8	85.71
		Transistor configurations - Common base configurations (α)		
		Common Emitter configurations – input and output characteristics		

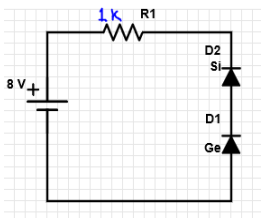
		Transistor amplifying action and Problems on Transistor		
		Types of MOSFETs		
		Enhancement-Type MOSFETs, drain and transfer characteristics		
		Electronic Communication systems		
		Modulation and Demodulation		
		Fundamental Concepts of Cellular Telephone,		
		Frequency Reuse		
UNIT-5				
37-42	**Core of the Embedded system**	Introduction to Embedded Systems	14.28	100
		Micro controller/Microprocessor		
		Memory/Communication Interface/ I/O systems		
		Introduction to ARM		
		Data flow model		
		Registers, Current Program Status Register, Processor modes, State and Instruction sets, Interrupt mask, Conditional Flags		

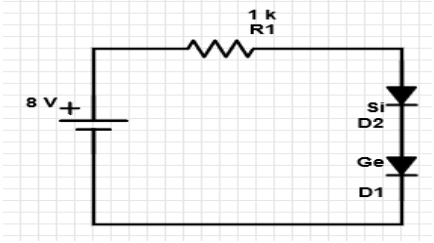
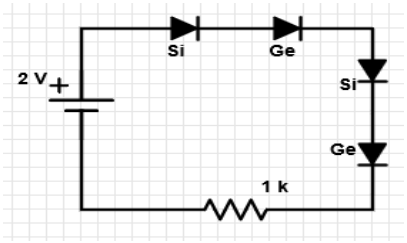
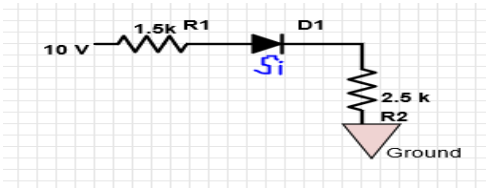
Reference book:

1. **"**Electronic Devices and circuit theory", Robert. L. Boylestad and Louis Nashelsky,PHI 10th Edition, 2009
2. "Digital Design with an Introduction to Verilog HDL" M Morris Mano, Michale D Ciletti Pearson
3. 5th Edition, 2013
4. "Electronic Communication Systems, Fundamentals through Advanced", Wayne Tomasi Pearson Education
5. 5th Edition 2004
6. "Introduction to Embedded Systems", Shibu K V Tata McGraw Hill 2009
7. "ARM System Developer's Guide" Andrew N. Sloss, Dominic Symes, Chris Wright Elsevier 2004

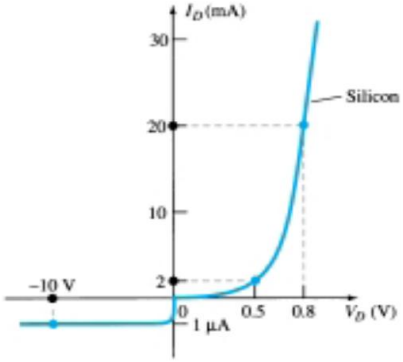
UE19EC101: FOUNDATION IN ELECTRONIC CIRCUITS AND SYSTEMS
Question Bank

	UNIT I: Introduction to Electronics and Semiconductor Diodes
1.	With a neat diagram explain the working of a pn-junction diode under forward bias. Draw the variation of forward current with respect to the forward voltage for both Si and Ge diodes.
2.	Explain the V-I characteristics of the diode using Shockley's equation.
3.	Explain the difference between AC resistance and Average AC resistance of a diode. From Shockley's equation, derive the expression for the AC resistance of the diode.
4.	Explain the effect of temperature on the following i) Knee voltage ii) Reverse saturation current iii) Breakdown voltage
5.	Explain the different types of breakdown that occur in diodes.

6.	What is the difference between the characteristics of a simple switch and those of an ideal diode?
7.	Give a comparison of Ge and Si.
8.	Explain the three models of a diode with the help of VI characteristics and equivalent circuits.
9.	Define Zener Diode, draw its equivalent diagram & discuss the V-I characteristics with graphs.
10	At a temperature of 27^0C, determine the thermal voltage V_T. Ans: 26mV.
11	Draw the different equivalent circuits of a diode and their VI characteristics. Which one of them closely resembles a practical diode?
12	What happens to cut-in voltage when the temperature increases? Ans: Cut-in voltage decreases.
13	When temperature increases, reverse saturation current _____ Ans: Increases.
14	What is meant by the PIV rating of a diode? Ans: Maximum reverse bias potential which can be applied across a diode without breakdown
15	Using Shockley's equation, determine the diode current at 20^oC for a silicon diode with I_S = 500pA and an applied forward bias of 0.5V. Ans: 0.196A.
16	From the given circuit diagram, what is the value of Si diode current?  Ans: I_D = 0.
17	The knee voltage of a Si diode is 0.7V and its reverse saturation current is 20nA at 25^oC. Determine these values at 40^oC. Ans: V_K at 40^oC = 0.6625 V, I_S at 40^oC = 55.18nA
18	The reverse saturation current of a Germanium diode is 200µA at room temperature of 27^oC. Calculate the current in forward biased condition, if forward biased voltage is 0.2V at room temperature. If temperature is increased by 30^oC, calculate the reverse saturation current and the forward current for the same forward voltage at new temperature. Ans: I_D at 27^oC = 0.465A, I_S at 57^oC = 1600 µA , I_D at 57^oC = 1.8A
19	Determine the diode current at 20^oC for a silicon diode with I_s =50 nA and an applied forward bias of 0.6 volts.

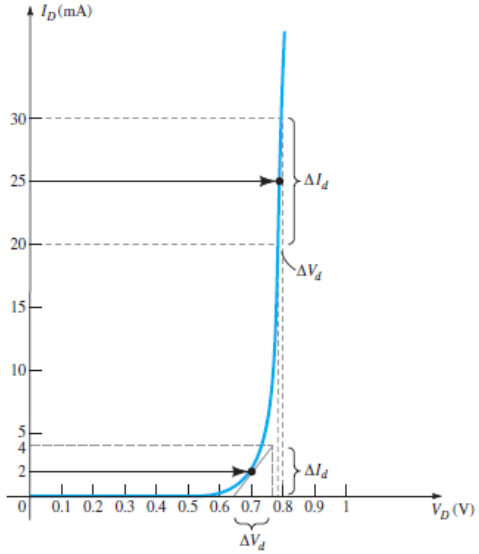
	Ans: I_D = 2.62 µA.
20	The reverse saturation current of a Si diode is 2pA at 27°C. Determine the forward biased voltage across the diode at 57°C, if the forward current through the diode at 57°C is 50mA. Ans: V_T = 0.02844V at 57°C, I_S = 16pA at 57°C & V_D = 0.622V at 57°C.
21	The knee voltage of Si diode is 0.7V & reverse saturation current is 20nA at 25°C. Determine the knee voltage at 40°C. Ans: Knee Voltage = 0.6625V at 40°C.
22	Reverse saturation current of Ge diode is 100µA at 27°C. If the diode current is 400mA calculate biasing voltage. Ans: V_T = 0.02587V at 27°C & V_D = 0.2145V at 27°C.
23	Reverse saturation current of Ge diode is 100µA at 27°C. If the diode current is 450mA calculate biasing voltage. Ans: V_T = 0.02587V at 27°C & V_D = 0.2176V at 27°C.
24	From the given circuit diagram, what is the value of diode current? Use an appropriate diode model.  Ans: I_D = 7 mA
25	From the given circuit diagram, what is the value of voltage across the resistor?  Ans: 0V
26	From the given circuit diagram, what is the value of diode current?  Ans: I_D = 2.325 mA
27	From the given circuit diagram of Q.No. 26 what is the value voltage across R2? Ans: 5.8125V
28	After cut-in voltage in piecewise linear model diode act as a _____ Ans: Conductor

29 Determine the dc resistance levels for the diode of Fig at (a) I_D= 2 mA (b) I_D= 20 mA (c) V_D= -10 V



Ans: (a) R_D = 250 Ω (b) R_D = 40 Ω (c) R_D = 10 MΩ

30 Determine the dynamic resistance of the diode of the figure given below at



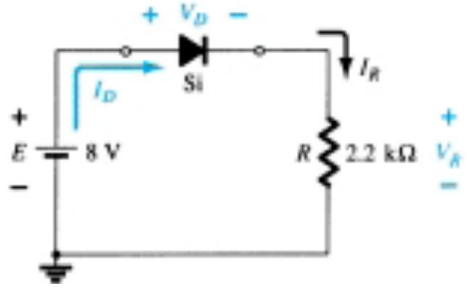
B. A forward current of 5mA using the Q-point method
C. A forward current of 5mA using the equation with values n=1 and V_T = 26 mV

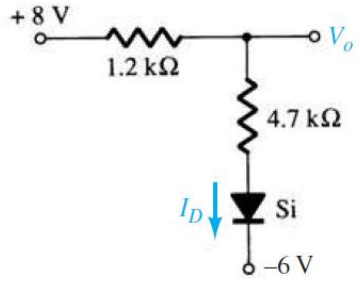
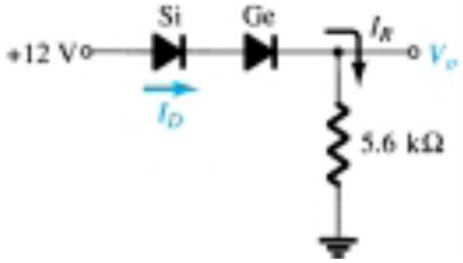
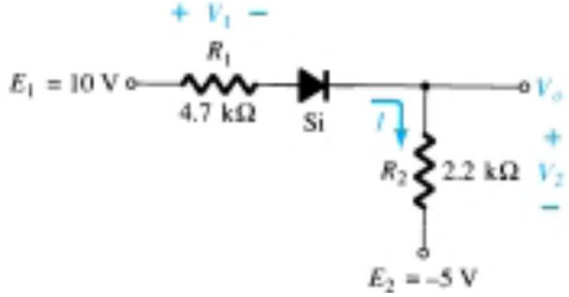
Ans: a) 3 Ω, b) 2.6 Ω.

31 Determine the dc and ac resistances of the diode with characteristics shown in the above problem at a forward current of 10mA and compare their magnitudes.

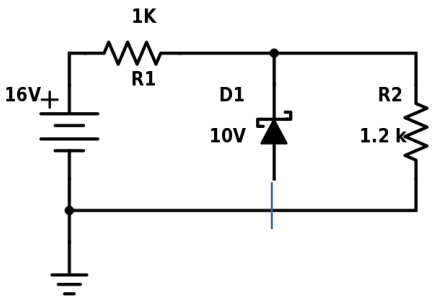
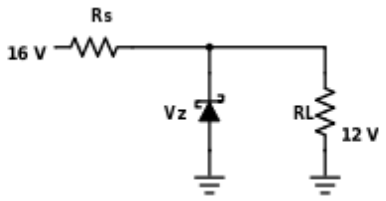
Ans : DC resistance : 76 Ω AC Resistance: 3 Ω

32 For the series diode configuration shown below, determine V_D, V_R, and I_D. Repeat the same if the diode is reversed.



	Ans: $V_D = 0.7V$, $V_R = 7.3V$, $I_D = 3.31mA$. If the diode is reversed, $V_D = 8V$, $V_R = 0$, $I_D = 0$
33	Determine Vo and Id for the series diode configuration shown below  Ans: $V_O = 6.53V$, Id = 1.24mA.
34	Determine *Vo* and *ID* for the series circuit.  Ans: $V_O = 11V$, $I_D = 1.964mA$
35	Determine *I*, *V*1, *V*2, and *Vo* for the series configuration.  Ans: $V_1 = 9.74V$, $V_2 = 4.56V$, $V_O = 0.44V$, I = 2.072mA
Unit II -Semiconductor Diode Applications	
36	With relevant waveforms, derive expressions for I_{DC}, Irms and ripple factor of a FWR assuming ideal diodes.
37	Explain how full–wave rectification is achieved using two diodes and center-tap transformer with a circuit diagram and output waveforms.
38	Explain the operation of bridge rectifier with circuit diagram and waveforms.
39	Give the advantages and disadvantages of Bridge rectifier over center-tap FWR.
40	Show that the ripple factor of a bridge rectifier is 0.48.
41	The input voltage to a half wave rectifier using Si diode is pure sine wave of peak value of 20V. The average value of input signal is, Ans: Zero

42	Define PIV/PRV and explain its significance.
43	A Bridge rectifier with ideal diodes has an ac source of RMS value 220 V, 50Hz connected to the primary of transformer. If the load resistance is 200Ω and turns ratio of transformer is 4:1, find the dc output volatge, dc output current and output frequency. Ans: V_{dc} = 49.5V, I_{dc} = 0.247A and f_o = 100Hz.
44	In a two diode FWR using Si diodes, the RMS voltage across each half of the transformer secondary is 100V. The load resistance is 975 Ω and each diode has a forward resistance of 25Ω Find (i) Average current (ii) Average output voltage (iii) PIV of diode. Ans: V_{dc} = 87.39V, I_{dc} = 0.089A and PIV= 282V.
45	A full wave bridge rectifier is constructed with Si diodes & source of V_{rms} = 120V has a load resistor of R_L = 1kΩ. Determine a) DC voltage available across R_L b) PIV rating of each diode c) find the maximum current through each diode during conduction d) what is the required power rating of each diode? Ans: a) V_{DC} = 107.04V b) PIV = 169V c) I_{max} = 168.3mA d) Power rating = 117.8 mW
46	A centre tapped full wave rectifier constructed with Si diodes has the secondary coil voltage of V_{RMS} = 20V with the load resistor of 1.5kΩ. Determine a) I_m b) I_{dc} & c) V_{RMS} across R_L. Ans: a) I_m = 18.38mA b) I_{dc} = 11.7mA & c) V_{RMS} across R_L = 19.5V
47	A full wave bridge rectifier constructed with Si diodes has the secondary coil voltage of V_{RMS} = 20V with the load resistor of 1.5kΩ. Determine a) I_m b) I_{dc} & c) V_{RMS} across R_L. Ans: a) I_m = 17.92mA b) I_{dc} = 11.4mA & c) V_{RMS} across R_L = 19.0V
48	Give any three differences between a zener diode and a rectifier diode. Define voltage regulator. What is the property of the zener diode which makes it suitable as a voltage regulator?
49	Explain the terms load regulation and line regulation.
50	Design a zener regulator that maintains V_0 at 10V for input voltage variation of 20V±10% and load current variation of 30mA ±20%. Given I_{Zmin} =2mA and P_{Zmax} =0.5W Ans: R_{Smin} = 162 Ω, R_{Smax} = 210 Ω, R_{Lmin} = 278 Ω, R_{Lmax} = 417 Ω
51	Design a Zener regulator that maintains V_0 at 10V for input voltage variation of 20V±20% and load current variation of 30mA ±20%. Given I_{Zmin} =2mA and I_{Zmax} = 40mA Ans: R_{Smin} = 187.5 Ω & R_{Smax} = 210.5 Ω
52	Design a Zener regulator that maintains V_0 at 10V for input voltage variation of 20V±20% and load current variation of 20mA ±10%. Given I_{Zmin} =2mA and I_{Zmax} = 50mA Ans: R_{Smin} = 205.8 Ω & R_{Smax} = 250 Ω
53	Determine the minimum and maximum values of R_L in a zener regulator to maintain V_O at 10V for an input voltage of 20V and R_S = 200Ω. Given P_{Zmax} = 600mW and I_{Zmin} = 1mA. Draw the circuit diagram. Ans: R_{Lmin} = 200 Ω, R_{Lmax} = 1K Ω
54	Determine the range of V_i that will maintain V_0 at 15V for a zener regulator. Given series resistor R=200Ω, R_L= 1.5KΩ, I_{zmin}=1mA and $P_{z\,max}$ = 0.5W. Draw the circuit diagram. Ans: V_{imin} = 17V, V_{imax} = 23.66V

55	In a Zener diode regulator, the input DC is 10 V±20%. The output requirement is 5 V and 20 mA. Assume I_{Zmin} and I_{Zmax} as 5 mA and 80 mA , design the voltage regulator. Calculate the power rating of the Zener diode. Ans: R_{Smax} = 120 Ω, R_{Smin} = 70 Ω, P_{Zmax} = 0.4W
56	Design a Zener regulator for the following sepcifications: output voltage= 5V, Load current =10mA, I_{Zmin} = 1mA, Zener wattage = 400 mW, Input voltage =10 V±2 V. Ans: R_L = 500 Ω, R_{Smin} = 77 Ω, R_{Smax} = 272 Ω
57	With circuit diagrams and relevant waveforms explain the working of FWR with shunt capacitor filter.
58	Zener regulator circuit has an input voltage of 50 Volts. I_{Zmax} of 32 mA and a series resistor of 1 KΩ. Determine the range of R_L and I_L that will result in the load voltage being maintained at 10 Volts. Determine the wattage rating of the diode. Draw the circuit diagram with all components values. Ans: R_{Lmin} = 250 Ω, R_{Lmax} = 1250 Ω, P_{Zmax} = 0.32W
59	For the Zener diode network, determine V_L, V_R, I_Z, P_Z  Ans: $V_{L=}$8.73V, V_R=7.27V, I_Z=0A, P_Z = 0 W
60	Design the network of figure to maintain V_L at 12V for a load variation from 0-200mA.  Ans: 30 Ω
61	Design a voltage regulator that will maintain an output voltage of 20V across a 1 kΩ load with an input that varies between 30V and 50V. Ans: Rs=500Ω, I_{ZM}=0.04A
62	Design a voltage regulator for input voltage variation of 8V-12V and load variation of 250Ω-10KΩ. Izmin=5mA, Vz=5V, Pz=400mW. Ans: Rsmin=86Ω, Rs max=120Ω, I_{Lmax}=0.02A
63	With relevant waveforms, derive expressions for I_{DC}, I_{rms} and ripple factor of a FWR assuming ideal diodes.
64	Draw the circuit diagram of a center tapped FWR with capacitor filter. If the filter capacitor is 120µF and load current of 80mA calculate the % ripple of the output. The FWR is operating from 50Hz supply and develops a peak rectified voltage of 25V. Ans: $V_{RMS(filter)}$ = 1.92V, $V_{DC(filter)}$ = 21.66V & ripple factor = 8.8%

65	A 500µF capacitor filter provides a load current of 200mA at 8% ripple to a FWR. Calculate the peak value of the rectified voltage obtained from a 50Hz supply and the DC voltage across the filter capacitor. Draw the circuit diagram. Ans: $V_{DC(filter)}$ = 14.4V & V_{peak} = 16.4V
66	Calculate the size of capacitor filter needed to obtain a filtered DC voltage of 24V having 15% ripple at a load of 150mA from a half wave rectifier operating with a supply of 60Hz. Ans: R_L = 160Ω & C = 200 µF
67	Calculate the % of ripple of a half wave rectifier with a capacitor filter 120 µF connected across the load drawing a current of 80 mA. The HWR is operating from 50Hz and develops a peak rectified voltage of 25V. Ans: $V_{RMS(filter)}$ = 3.84V, $V_{DC(filter)}$ = 18.33V & ripple factor = 20.8%
68	Calculate the size of capacitor filter needed to obtain a filtered DC voltage of 24V having 5% ripple at a load of 150mA from a full wave rectifier operating with a supply of 60Hz. Ans: $V_{RMS(filter)}$ = 1.2V & C = 300 µF
	Unit III: Digital Electronics
69	Simplify the following Boolean expressions and realize using NAND gates 1. Y= AB'C'+A'B'C'+A'B'+AC' Ans: Y = A'B' + AC' 2. Y=((A+B'C)(A'+B'+C')(A'+B))' Ans: Y = B' + A'C' + AC 3. Y=(A'B+A'+AB)' Ans: Y = AB' 4. Y=(A+B'+C)(A'+B+C')(A+B') Ans: Y = AB + AC' + A'B' + B'C'
70	Given a function *F=A(B+C(AB+AC)') Simplify* and realize using basic gates. Ans: Y = AB
71	Simplify the following Boolean expression and realize the simplified expression using NOR gates. Y = $A\ C + B\ C\ AB + ABC$ Ans: Y = A + BC
72	Design a logic circuit using minimum number of basic gates with three inputs A,B,C and output that goes low only when A is high and B and C are different. Write its truth table. Ans: Y = A' + BC + B'C'
73	Realize 3 input XOR gate using i. 2 input NAND gates ii. 2 input NOR gates
74	Write the Truth table and logic expressions for Sum and Carry of a (i) Half adder (ii) Full adder
75	Write the expressions for the output of 2-to-1 MUX
76	Write the expressions for the output of 1-to-2 DEMUX
77	Realize SR Flip flop using Nand gates
78	Realize JK,T and D Flip flop
79	Discuss the usage of counters and Registers in Design of Logical circuits

	Unit IV : Transistors and Communication systems
80	Draw the output characteristics of a transistor in CE configuration and mark the different regions of operation and briefly explain them.
81	Draw the output characteristics of a transistor in CB configuration and mark the different regions. Write the biasing, characteristic property of the transistor and the output current equation in the active region
82	A Ge transistor with αdc = 0.98 gives ICBO = 12μA when used in CB mode. When the transistor is connected in CE mode, the base current is 0.2mA. Calculate IC and IE in CE mode. Ans: IC = 10.4mA, IE = 10.6mA
83	If the emitter current of a transistor is 8mA and IB is 1/100 of IC, determine the levels of IC and IB. Ans: IC = 7.92mA, IB = 0.08mA.
84	Define α and β of a transistor and derive the relation between them.
85	(a) Given that αdc = 0.987, determine the corresponding value of βdc. (b) Given βdc = 120, determine the corresponding value of α. (c) Given that βdc = 180 and IC = 2.0 mA, find IE and IB. Ans: IE = 2.01mA, IB = 11μA
86	Draw the input characteristics of the transistor in the CE configuration and briefly explain it. Explain how the dynamic input resistance of the transistor can be determined from the characteristics.
87	Explain the construction, operation and characteristics of n-channel Enhancement type MOSFET
88	The maximum drain current for the 2N4351 n- channel enhancement type MOSFET is 30 mA. Determine VGS at this current level if k = 0.06 x 10-3 A/ V2 and VT is the maximum value. Ans : VGS = 27.36 V
89	With a neat diagram explain Typical Communication Systems.
90	What is the need for Modulation?
91	List the different Types of Modulation.
92	Differentiate between Analog and Digital Modulation.
93	Describe the cellular system for mobile communication.
94	What is frequency Reuse? Explain
95	Illustrate Roaming and handoff concepts in Mobile communication
96	The modulation technique used for mobile communication systems during world war II was a. Amplitude modulation b. Frequency modulation c. ASK d. FSK

	ANSWER: Frequency modulation
97	———– introduced Frequency Modulation for mobile communication systems in 1935. a. Edwin Armstrong b. Albert Einstein c. Galileo Galilei d. David Bohm ANSWER: Edwin Armstrong
98	The early FM push-to-talk telephone systems were used in a. Simplex mode b. Half duplex mode c. Full duplex mode d. None of the above ANSWER: Half duplex mode
99	DECT stands for a. Digital European Cellular Telex b. Digitized Emergency Cellular Telephone c. Digital European Cordless Telephone d. Digital European Cellular Telephone ANSWER: Digital European Cordless Telephone
10	World's first cellular system was developed by a. Nippon Telephone and Telegraph (NTT) b. Bellcore and Motorola c. AT&T Bell Laboratories d. Qualcomm ANSWER: Nippon Telephone and Telegraph (NTT)
10	Paging systems were based on a. Simplex systems b. Half duplex systems c. Full duplex systems d. None of the above ANSWER: Simplex systems
10	Paging systems could be used to a. Send numeric messages b. Send alphanumeric messages c. Voice message d. All of the above ANSWER: All of the above
	Unit V: CORE OF THE EMBEDDED SYSTEM
10	Write the full form of the following: a) RISC b) CISC c) FPGA

	d) CPSR
10	Distinguish between the following: a) Microprocessor (MP) & Microcontroller (MC) b) General Purpose Processor (GPP) & Application Specific Instruction Set Processor (ASIP)
10	Write a short note on each of the following? a) Microprocessor (MP) b) Microcontroller (MC) e) Read Only Memory (ROM) & Random Access Memory (RAM)
106.	Mention the operating modes of ARM processor.
107.	Draw the block diagram of Embedded System and explain each block.
108.	What is a Sensor & Actuator? Give an example for each.
109.	Mention any five I/O subsystems.
110.	Explain the function of communication Interface.
111.	Explain the Data flow model
112.	Explain the processor modes in Current Program Status Register (CPSR)
113.	Draw the Data flow model flow chart.

UE19BT101: ENGINEERING BIOLOGY (2-0-0-0-2)

No. of Hours: 26

Class No.	Chapter Title / Reference Literature	Topics to be covered	% of Portions covered	
			Reference chapter	Cumulative
UNIT 1				
1	**BIOMIMETICS**	Introduction to Biology: Biological Unity underlies Biological diversity	19	19
2,3		Biomolecules: Water,Carbohydrates,Proteins, Lipids and Nucleic acids		
4,5		Biomimetics: Nature as an engineer, Bio-processes -engineering analogies		
UNIT 2				
6	**BIOENERGY**	Plant & Animal cell	19	38
7		Metabolism: Enzymes & Bio-catalysis		
8		Anabolism: Solar to Bioenergy : Photosynthesis		
9		Catabolism: Digestion: Breakdown of food		
10		Respiration : Gas exchanges		
UNIT 3				
11,12	**BIOMECHANICS**	Bio-fluidics: Blood- Mechanical systems of the heart, Blood pressure	19	57
13		Molecular Motors: rotational motor mechanism in ATP synthesis		
14,15		Kinesiology: Bio-mechanistic processes involved in movement, Muscle Contraction-relaxation		
UNIT 4				
16	**BIOELECTRONICS**	Brain as computer: Bio-neural networks	19	76
17		Bionic Eye: Mechanism of Vision		
18		Electronic Nose: Bio-olfactory mechanisms		
19		Cardiac and Nerve impulses		
20		Biological Clock, Circadian rhythm		
UNIT 5				
21,22	**BIOPHARMA**	Metabolic Disorders, Cancer and Diagnostics	24	100
23		Lab on a chip		
24		Bio-Sensors		
25		Telemonitoring		
26		Drug Discovery		

Reference Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Lehninger Principles of Biochemistry", David Nelson, Michael Cox, W H Freeman & Company, Seventh Edition, 2017.
3. Biomimicry: Innovation inspired by Nature, Janine M Benvus, 2002

UE19PH101 ENGINEERING PHYSICS (4-0-0-0-4)

LESSON PLAN

Unit No. / Title	Class No	Portion to be covered	% of portion covered
Unit I Introduction to Quantum Mechanics	1.	Concept of Electric and Magnetic fields	15.38
	2.	Maxwell's equations – concept of the radiation as EM waves, and energy content of the waves.	
	3.		
	4.	Failures of classical EM wave theory – BB radiation, atomic spectra, photo electric effect	
	5.	Compton Effect (with derivation of Compton shift)	
	6.	Wave particle duality, de Broglie hypothesis- matter waves double slit experiment	
	7.	Phase velocity, Wave packet, Group velocity, Expression for group velocity in terms of phase velocity	
	8.	Heisenberg's Uncertainty principle Gamma ray microscope and applications	
Unit II Quantum Mechanics of simple systems	9.	Wave function: properties and physical significance, probability density Normalization of wave function. Concepts of linear superposition of wave functions.	23
	10.	Observables, quantum states, operators and expectation values.	
	11.	One dimensional time independent Schrödinger's Wave equation.	
	12.	Free particle solution. Step Potentials : solution of Schrödinger's wave equation for particle with E>Vo and E<Vo.	
	13.		
	14.	Barrier Potentials: solution of Schrödinger's wave eqn. Discussion of the wave function in the different regions and expression for tunneling coefficient. Radioactivity as an example of barrier tunneling	
	15.		
	16.	Discussion of solution of a particle in an infinite potential well, Eigen values, Eigen functions and probability densities.	
	17.		
	18.	Concept of particle in two and three dimensional box. Energy state distributions concept of degeneracy of energy states	
	19.	Eigen values and Eigen functions for a particle in a 1d finite potential well	
	20.	Linear Harmonic oscillator – concept of a variable potential energy factor and implications on the solutions of Schrodinger's equation.	
Unit III Application of Quantum Mechanics to	21.	Review - electrical conduction expressions and failures of the classical free electron theory	17.30
	22.	Concepts of Quantum free electron gas	
	23.	Fermi energy, Fermi Dirac statistics, Fermi factor Density of states	

Solids	24.	derivation, graphical representations of g(E) and N(E)	
	25.	Expression for Fermi energy, Fermi temperature, Fermi velocity, average electron energy	
	26.	Merits of Quantum free electron theory: Heat capacity due to free electrons Temperature dependence of resistance Relation between electrical conductivity and thermal conductivity (Wiedemann-Franz law and Lorenz number) Demerits of quantum free electron theory	
	27.		
	28.	Motion of electron in periodic potential (one dimensional treatment) Bloch theorem	
	29.	Electron motion in a periodic potential, E-k diagrams and formation of energy bands	
	30.	Effective mass of charge carriers in a periodic potential	
Unit IV Application of Quantum Mechanics to Electromagnetic Waves	31.	Black body radiation as an equilibrium state.	28.84
	32.	Introduction: Quantum transitions, Einstein's coefficients, Expression for energy density	
	33.	Properties of LASER – Coherence, monochromaticity, directionality.	
	34.	Condition for laser action in two, three and four level systems, requisites of a laser system	
	35.	Light amplification Gain and loss processes,	
	36.	Condition for round trip gain, cavity design considerations.	
	37.	Requirements of a LASER – active medium, energy pump and resonant cavity	
	38.	He Ne Laser: working with energy level diagram	
	39.	CO_2 laser: principle and working	
	40.	Concept of Light emitting diodes using direct band gap semiconductors	
	41.	Semiconductor laser energy band diagram and population inversion conditions Homo junction and Hetero junction devices	
Unit V Dielectric and Magnetic Materials	42.	Introduction, Magnetic dipoles, Magnetic susceptibility, concepts of field quantities H,B, and M.	15.48
	43.	Diamagnetic and Para magnetic materials Ferromagnetic, anti-ferromagnetic and ferri magnetic materials (ferrites).Origin of magnetization – atomistic. Spin magnetic moment and Larmor precession.	
	44.		
	45.	Brillouin function and Langevin's theory of paramagnetism	
	46.		

	47.	Applications of magnetic materials – Memory and GMR	
	48.	Polarisation mechanisms in dielectrics	
	49.	Piezo electric materials - properties and applications	
	50.	Pyro electric materials -properties and applications	
	51.	Ferroelectrics - BaTiO3 structure and origin of non-centro symmetry of charges, phase changes, hysteresis and application as memory materials	
	52.		
	53-56	Revision classes	

Reference Books:

1. Eisberg, Robert and Resnick, Robert (2006) Quantum Physics of Atmos Nuclei and Molecules, Wiley.
2. Gasiorowicz, S (2007) Quantum Physics, 3rd Edition,Wiley.
3. Sankar, R (2010) Principles of Quantum Mechanics, Pearson.
4. Feynman, Leighton and Sands, (2012) Lectures on Physics, Vol 1-3, 13th Reprint, Narosa.
5. Beiser, Arthur (2015) Concepts of Modern Physics, 6th Edition, McGrawHill

Other Resources

Lecture Notes and Review Articles

Question Bank

Unit I: INTRODUCTION TO QUANTUM MECHANICS

44. What is the fundamental difference between the integral and the differential form of Maxwell's equations?
45. Which are the two homogenous equations of the four Maxwell's equations?
46. Which are the Maxwell's equations which contains 'sources'?
47. How does Maxwell's equations describe electromagnetic waves
48. Derive Maxwell's equations for harmonically varying fields.
49. Show that the ratio of the electric and magnetic fields of a uniform plane wave is constant depending upon the medium.
50. Explain how Poynting vector explains the energy flow.
51. Differentiate between circularly and elliptically polarized light?
52. What is the concept of energy of the waves according to classical electromagnetic wave theory?
53. How do the atomic spectra support the quantum principles?
54. Why couldn't classical electromagnetic theory of light explain photoelectric effect?
55. Mention the characteristics of a black body spectrum.
56. Explain Planck's formula for black body radiation and deduce Rayleigh-Jeans' law from Planck's equation.
57. Calculate the average energy of the Planck's oscillator of frequency 5.6×10^{12} Hz at 330 K (Answer: 2.945×10^{-21} J)
58. What is Compton Effect? Why X-rays are best suited for the study of Compton Effect?
59. Why classical physics cannot explain the results of Compton's experiment?
60. Write the conservation of momentum expressions in explaining Compton Effect.
61. What is Compton shift and what are the physical inferences drawn from this expression?

62. Write the energy imparted to the electron when scattered by X-Rays in Compton Effect.
63. What are the angles at which the Compton shift is minimum and maximum? What are the conclusions drawn from these angles?
64. What is the energy of the smallest energy X-ray photon for which the Compton scattering could result in doubling the original wavelength? (Answer: 0.25 MeV)
65. The shift in the wavelength of X-rays scattered in a Compton Effect experiment is 0.2 pm. If the wavelength of the scattered X rays is 1.002 nm find the angle at which the X- ray photon is scattered and what is the momentum gained by the electron?
66. Explain the theoretical considerations which led de-Broglie to the concept of matter waves.
67. What are matter waves? State de-Broglie hypothesis.
68. Find the K.E. and velocity of proton of mass 1.67×10^{-27}kg, associated with de-Broglie's wavelength of 0.2865 Å (Answer: v = 13.847 km/sec and K.E. = 1 eV)
69. Why is the wave nature of matter not apparent for macroscopic particles? A bullet of mass 40g travels at 1000m/s. What wavelength can we associate with it? Does it support the answer given to the first part of the question? (Answer: wavelength of wave associated with bullet is 1.66×10^{-35}m)
70. The mass of an oxygen molecule is 5.4×10^{-26} Kg. If this molecule moves with a speed of 500m/s, calculate the de-Broglie wavelength of the wave associated with the molecule? (Answer: λ = 0.0256μm)
71. Distinguish between phase and group velocities.
72. Show that the phase velocity of the de-Broglie waves for a particle is a function of the wave length?
73. State Heisenberg's uncertainty principle. In an experiment the wavelength of a photon is measured to an accuracy of one part per million. What is the minimum uncertainty, Δx, in a simultaneous measurement of the position of the photon in case of a photon of wavelength 600 nm. (Answer: Δx = 47.78 nm)
74. Arrive at Heisenberg's uncertainty principle with the help of a thought experiment.
75. Uncertainty principle is not significant in case of macro-bodies. Justify.
76. Monochromatic light passes through a shutter that opens for a time $\Delta t = 10^{-10} secs$. What is the spread in the frequency caused by the shutter?
77. An electron moves in the x-direction with a speed of 3×10^{6} m/s. We can measure its speed to a precision of 1% (a) with what precision can we simultaneously measure its position? What can we say about its motion in the y-direction? (Answer: Δx = 1.935nm).
78. An electron is confined to a spherical box of diameter 10^{-8} m. Calculate the minimum uncertainty in its velocity. (Answer: $\Delta v = 0.116 \times 10^{5}$ m/sec)
79. Wavelengths can be determined with accuracies of one part in 10^{8}. What is the uncertainty in the position of 1Å X-ray photon when its wavelength is simultaneously measured? (Answer: 8×10^{-14} m)

Unit II: QUANTUM MECHANICS OF SIMPLE SYSTEMS

80. Give physical interpretation of wave function. State and explain normalization of wave function.
81. Prove that Ψ*(x,t) Ψ(x,t) is necessarily real and either positive or zero.
82. Explain the concept of probability addition in the light of a double slit experiment.
83. Why does the probability density function have to be real, finite and non-negative everywhere?
84. Explain the concept of "expectation value of a physical measurable quantity" in quantum mechanics?
85. What are observables? Give an example.
86. Define operator? Write operator for momentum, position, kinetic energy and energy.

87. A wave function is given by $\psi(x) = A\,Sin\,(Kx)$ in the region $0 < x < a$. Find the probability density and normalization constant A.
88. Consider the normalized wave function of a particle as given by
    $\psi(x) = 2\alpha\sqrt{\alpha}.xe^{-\alpha x}\ \ for\ x > 0$
    $\psi(x) = 0\ for\ x < 0$
    Calculate the maximum of the probability P(x) and find the expectation values <x> and <x^2>
89. How does the Schrödinger wave equation differ from the classical wave equation?
90. Why is Schrodinger's equation referred to as a linear equation?
91. Explain observables and operators.
92. Set up time- independent Schrödinger wave equation.
93. A free particle is a classical entity. Justify.
94. Schrodinger's equation is an operator equation. Explain
95. A beam of particles, each of total energy E, strikes a potential step of height V_0 located at x =0. If E > V_0 then, show that the de Broglie wavelength in the region x< 0 bears a constant ratio to the de Broglie wavelength in the region x > 0 and this ratio is independent of the particle type. Assume that at x <0, V = 0 and x >0, V = V_0.
96. A particle of mass m and total energy E moves from a region of constant potential V_1 to a region of constant potential V_2. Derive expression for reflection and transmission coefficients when V_1<E<V_2.
97. Estimate the transmission coefficient of electrons with 8 MeV and a Barrier height of 16 MeV of width 2 nm.
98. Define the terms reflection coefficient and transmission coefficient with respect to step potential.
99. Explain the significance of penetration depth.
100. Determine the transmission coefficient for a proton of energy 1Mev through a 4Mev high rectangular potential energy barrier of width 10^{-12} cm. (Answer: T = 5.03 x 10^{-4})
101. What is tunnel effect? How is it used to explain alpha decay?
102. Show that the energy of an electron confined in a 1-D symmetric potential well of length 'L' and infinite depth is quantized. Is the electron trapped in potential well allowed to take zero energy? If not, why?
103. Show that E= $h^2n^2/8ma^2$ for an infinitely deep potential well of width of "a" can be obtained directly from the de-Broglie relation p = h/λ, by fitting an integral number of half de-Broglie wave length λ/2 in to the width "a" of the well.
104. Find the expectation value <x> of the position of a particle trapped in a box 'L' wide.
105. Plot the probability densities for the first three excited quantum states of an electron trapped in an infinite potential well of width L. Calculate the probability of locating the electron in the third excited state between the limits ⅜L and ⅝L where L is the width of the well? (Answer P = 0.25)
106. Show that the probability of locating the particle between the limits 0 to 0.5L is the same in any quantum state. Here L is the width of the well.
107. Find the least energy of an electron moving in one-dimensional potential box (infinite height) of width 0.05 nm.
108. What is meant by degeneracy of energy states in quantum systems?
109. Give examples of degenerate states in the case of a particle in a three dimension box with infinite potential at the boundaries.
110. A particle trapped in a finite potential well. Sketch the Eigen functions for first three energy states.

111. Elaborate the concept of parity as applied to Eigen functions. When is it possible to describe the parity aspect of Eigen functions?
112. Compare the energy levels of the first three quantum states of identically sized finite and infinite potential wells.
113. What is a linear harmonic oscillator? When can the oscillations become "anharmonic"?
114. The lowest energy of the harmonic oscillator is non zero. Explain why?
115. What mathematical functions best describe the Eigen functions of a linear harmonic oscillator?
116. What are the classical "turning points" of an oscillator?
117. Where is the concept of linear harmonic oscillator used in Physics?
118. The eigen functions of a particle performing linear harmonic oscillations is given by $\Psi(x) = \left[2n\left(\sqrt{\pi}\right)n!\right]^{-½} exp^{\left(-\frac{x^2}{2}\right)} Hn(x)$ where $H_n(x) = (-1)^n \exp(x^2)\, d^n/dx^n\, (\exp(-x^2))$. Write down the mathematical expressions for the Eigen functions for the first four quantum states.

Unit III: APPLICATION OF QUANTUM MECHANICS TO SOLIDS

119. Bring out the salient features of Drude-Lorentz theory and mention the drawbacks of the classical free-electron theory.
120. Define, (i) drift velocity (ii) relaxation time (iii) mean collision time (iv) mean free path and (v) mobility of electrons.
121. Distinguish between drift velocity and thermal velocity of an electron.
122. Mention the postulates of quantum free electron theory of metals.
123. How does quantum free electron theory explain the electrical conductivity of metals?
124. Explain Fermi level and Fermi energy.
125. Explain the distribution of electrons at 0K based on the quantum theory.
126. Explain the concept of Fermi factor and discuss its temperature dependence.
127. Show that the probability of occupancy of an energy level ΔE below the Fermi level is the same as that of the probability of non-occupancy of an energy level ΔE above the Fermi level.
128. Discuss the behavior of Fermi factor for cases $E< E_F$ and $E> E_F$ at T=0K and T>0K.
129. What is the significance of Fermi factor? Graphically represent the variation of the Fermi factor with energy for temperature, (i) T=0K and (ii) T>0K
130. Use the Fermi distribution function to obtain the value of f(E) for $E-E_F$ = 0.01 eV at 200 K.
131. Calculate the energy of an energy state whose probability of occupancy is 0.05 at 500K.
132. At what temperature would the probability of occupancy of an energy state 0.01eV be 0.95.
133. Determine the Fermi temperature and Fermi velocity in a metal with 18×10^{28} free electrons per unit volume.
134. Explain the concept of density of states in metals and derive an expression for the same.
135. Obtain an expression for Fermi energy using the concept of density of states.
136. Arrive at an expression for the Fermi energy of a metal at T=0K in terms of the number density of electrons in the valence band.
137. The electrons near the Fermi level contribute to the specific heat of metals. Explain.
138. Describe Matthiessen's rule.Discuss how temperature and impurities affect the resistivity of metals?
139. Mention the expressions for electrical and thermal conductivities of a metal and hence obtain the Wiedemann-Franz law.
140. Deduce the Lorentz number.
141. Discuss the merits and demerits of the quantum free electron theory.

142. Explain the terms (i) Periodic potential (ii) Bloch function and (iii)Effective mass
143. What is Bloch function and how is it different from the free electron wave function?
144. Outline the Kronig Penny Model to describe the motion of electrons in a metal and discuss how the band structure evolves from this model.
145. Draw the E-K graph for electrons in metal as per the band theory of solids and discuss the concept of the effective mass of electrons in the conduction band of the metal.
146. How does the potential energy of an electron vary in an infinite one dimensional crystal and how this potential is represented in Kronig-Penny model?
147. Discuss the E-k diagram and give a qualitative picture of the origin of band gaps.
148. The "effective mass" of electrons depends on the curvature of the E-k plot. Explain this statement.
149. Distinguish between conductors, insulators and semiconductors on the basis of band theory of solids.
150. Calculate the density of occupied states, for copper, at an energy level which is 0.026 eV above the Fermi level, at a temperature 300K. Assume Fermi energy of copper as 7eV. (Answer: 3.02×10^{46} states/m^3/J)

Unit IV: APPLICATION OF QUANTUM MECHANICS TO ELECTROMAGNETIC WAVES

151. Discuss the Processes of interaction of radiation with matter.
152. What are Einstein's coefficients? Show that the probabilities of induced absorption and stimulated emission are equal.
153. Arrive at an expression for the energy density of electromagnetic radiation in terms of Einstein's coefficients.
154. Show that at thermal equilibrium the ratio of the coefficient of spontaneous emission to the coefficient of stimulated emission is proportional to ν^3.
155. Explain the terms, (i) absorption (ii) spontaneous emission (iii) stimulated emission (iv) metastable state (v) pumping mechanism (vi) population inversion (vii) active medium and (viii) optical or laser cavity
156. State essential differences between laser and ordinary light?
157. What are the important characteristics of laser radiation?
158. Explain the following typical characteristics of a laser i) coherence ii) divergence and iii) monochromaticity.
159. Discuss temporal and spatial coherence of a laser?
160. Laser radiation is not truly monochromatic. Explain
161. Discuss the fundamental requirements of a laser system. Explain why laser emission is not feasible in a two level system.
162. Bring out the difference between three level and four level lasers.
163. Explain the necessary conditions for designing a laser cavity?
164. Discuss with appropriate energy level diagram, how the He-Ne laser system works as a continuous laser.
165. Elaborate the round trip gain of a Laser. Obtain an expression for threshold round trip gain in a laser cavity.
166. What is the role of Helium atoms in He-Ne laser?
167. How does one eliminate the unwanted IR radiation that accompanies the visible radiation in He-Ne laser?
168. What is a molecular laser? Give an example.
169. Using the energy level diagram, explain the working of CO_2 laser.
170. What are the three modes of vibrations of a CO_2 molecule?

171. What are direct and indirect band gap semiconductors? Explain using E-K diagrams.
172. Using a neatly labeled energy level diagram, explain the principle and working of a semiconductor laser.
173. Distinguish between homo-junction and hetero-junction semiconductor lasers.
174. Discuss in detail the techniques– charge confinement and photon confinement with reference to semiconductor laser
175. If the band gap of direct band gap semiconductor is 0.2 eV, estimate the wavelength of laser emitted from it. To which region of electromagnetic spectrum does it belong?

Unit V: APPLICATION OF QUANTUM MECHANICS TO MAGNETIC MATERIALS AND DIELECTRICS

176. Discuss the classification of magnetic materials
177. Define the terms: magnetic susceptibility, magnetic permeability and magnetization.
178. Define magnetic moment. Explain the origin of magnetic moment at the atomic level.
179. What is Bohr magneton? How is it related to magnetic moment of electron.
180. Explain gyro magnetic ratio as applied to magnetic materials.
181. Explain how an electron is a tiny magnet?
182. Give the range of susceptibility values for each class of magnetic material.
183. Discuss the temperature dependence of susceptibility for each type of magnetic material.
184. Explain hysteresis of a ferro-magnetic material.
185. Why do you think iron exhibits ferromagnetism? Apart from iron which other elements exhibit ferromagnetism?
186. Explain ferri-magnetism and anti-ferromagnetism.
187. Describe hysteresis loop. How is it used to classify magnets?
188. Explain the difference between the terms 'Curie temperature' and 'Neel temperature'.
189. Explain classification of magnetic materials on the basis of electron spin.
190. What is Larmor frequency?
191. Explain the salient features of quantum theory of paramagnetism.
192. Compare essential characteristics of Lenz' law (macroscopic) and diamagnetism.
193. A material always has negative magnetic susceptibility. What type of material is it? Which material(s) exhibit perfect diamagnetism?
194. A material's magnetic susceptibility is independent of temperature. What type of material is it?
195. How does the magnetic susceptibility of a paramagnetic specimen vary with temperature?
196. Discuss the how M varies with H for each class of magnetic material. What is GMR? Mention important applications.
197. Calculate the magnetic dipole moment associated with an electron moving in a circular path of radius 0.0529 Å. (answer $\mu = 9.27 \times 10^{-24}$J/T)
198. What are the characteristics of a magnetic material for memory storage applications?
199. Explain the behavior of dielectrics under static electric fields and with usual notations show that $P = \varepsilon_0(\varepsilon_r-1)E$.
200. A dielectric slab of constant 6 is kept between the plates of a parallel plate capacitor. If the charge on the plates is 10μC and the area of the plates is $1cm^2$ what is the polarization induced in the specimen? (Answer $P = 0.0833C/m^2$)
201. Find the electric field required to produce a polarization of $6.2 \times 10^{-12}Cm^{-2}$ in a dielectric medium of dielectric constant 12. (Answer E = 0.764N/C)

202. A dielectric material is kept between the plates of a parallel plate capacitor. If the plates have a charge density of $10^3 Cm^{-2}$ and the induced charged density on the surface of the dielectric is 9 x $10^2 Cm^{-2}$ then calculate the dielectric constant of the dielectric material. (Answer $\varepsilon_r = 10$)
203. Explain the origin of different kinds of polarization.
204. How does dielectric constant of a solid containing permanent dipole vary with temperature?
205. What is meant by local field in a dielectric material?
206. Explain Clausius-Mossotti relation in dielectrics subjected to static fields.
207. Discuss the concept of centro-symmetry in crystals?
208. Non-linear dielectrics are active dielectrics. Justify.
209. Explain the phenomenon of ferro-electricity with particular reference to Barium Titanate.
210. Graphically show how the dielectric constant of Barium titanate varies with temperature, both below and above the Curie temperature?
211. Explain the behavior of piezoelectric materials? Give an application of piezoelectric materials.
212. What is inverse piezoelectric effect?
213. What are pyroelectric materials and give an example of this kind of material? Suggest an application of pyroelectric materials/devices.
214. The hysteresis is a memory phenomenon. How can this property of ferroelectrics be used to make memory devices?
215. An elemental dielectric has $\varepsilon_r = 12$ and contains 5 x 10^{28} atoms m^{-3}. Calculate the electronic polarizability of the material. (Answer : $\alpha = 4.18 \times 10^{-40} Cm^2/V$)

UE19ME101: MECHANICAL ENGINEERING SCIENCES (3-0-0-0-3)
LESSON PLAN

NO. OF HOURS : 42

Class No.	Reference	Topic	Percentage of syllabus covered	Cumulative percentage of syllabus covered
1	R2 - chapter 1	**Unit 1** Energy Sources and Power Generation: Description of energy, energy consumption	3	3
2	R2 - chapter 1	classification of resources, salient features and drawbacks of conventional and non-conventional energy sources, Renewable and non renewable energy sources	3	6
3	R2 - chapter 1	energy scenario in India, various aspects of energy conservation, principles of energy conservation.	2	8
4	R2 - chapter 1	Solar Energy: sun as source, earth, spectral energy distribution, depletion of solar energy, working principles of solar collectors, water heaters,	2	10
5	R2 - chapter 1	cookers, furnaces and desalination, solar cell,	2	12
6	R2 - chapter 1	Wind energy, major applications, wind energy conversion system, environmental aspects,	2	14
7	R2 - chapter 1	Biomass energy, Geothermal energy, Tidal energy, Wave energy - working principles, fuel cell - working principles,	2	16
8	R2 – chapter 2	Working principles of thermal and nuclear power plant,	2	18
9	R2 – chapter 2	Hydro electric power plant – Hydraulic turbines classification, principles and operation of pelton wheel turbine, Francis turbine and kaplan turbine working principles.	2	20
10	R2 – chapter 3	**Unit 2** Thermal Energy Systems: review of working principle of an IC Engine - 2 and 4 stroke IC Engines, Working principle of 4 stroke SI engine, vehicles.	3	22
11	R2 – chapter 3	Working principle of 4 stroke CI engine, comparison of 4 stroke SI and CI engines, simple numerical on IC engines. Hybrid vehicles and Electric vehicles	2	24
12	R2 – chapter 3	Steam: formation of steam, and thermodynamic properties of steam	2	26

13	R2 – chapter 3	(simple numerical)	2	28
14		steam turbines working principles, applications, classification - impulse turbines	3	31
15	R2 – c hapter 1	reaction turbines, comparison of impulse and reaction turbine,	3	34
16	R2 – chapter 1	Refrigeration - description, principle of refrigeration, unit, COP, heat pump definition, refrigerants types,	3	37
17	R2 – chapter 1	Working principles of vapour compression & vapour absorption refrigeration systems	3	40
18	R1 - Chapter 1&2	**Unit 3** Engineering Materials: Description, mechanical properties, Mechanical testing of materials - tensile and compression.	2	42
19	R1 - Chapter 1&2	Classification of engineering materials: ferrous, non-ferrous, plastics, abrasives, ceramics, silica, glass and composites,	2	44
20	R1 - Chapter 1&2	Stress and Strain: Two force member, axial loading, definition, units and classification of stress and strain, Numericals	2	46
21	R1 - Chapter 1&2	salient features of Engineering stress strain - diagram for brittle	2	48
22	R1 - Chapter 1&2	salient features of Engineering stress strain - diagram for ductile material	2	50
23	R1 - Chapter 1&2	factor of safety, poisson's ratio,	2	52
24	R1 - Chapter 1&2	extension in varying section members,	2	54
25	R1 - Chapter 1&2	stress and strain in composite members,	3	57
26	R1 - Chapter 1&2	Relation between stress, volumetric strain, modulus of elasticity, modulus of rigidity, bulk modulus - Numericals	3	60
27	R2 – chapter 9	**Unit 4** Power Transmission: Power transmission systems - types: belt, chain, rope and gear	2	62
28	R2 – chapter 9	belt drive - velocity ratio, description of slip and creep in belt drives,	2	64

29	R2 – chapter 9	types of belt sections; open and cross belt drives; tight and slack sides; pulleys - stepped cone pulleys, ratio of tensions in open belt drives (flat and v-belt),	3	67
30	R2 – chapter 9	power transmitted; simple numericals based on the same.	2	69
31	R2 – chapter 9	Gear Drives: description, velocity ratio, train value,	2	71
32	R2 – chapter 9	gear classification - (i) Spur gears ii) Helical gears iii) Worm and worm wheel iv) Rack and pinion v) Bevel gears based on shafts and teeth meshing,	3	74
33	R2 – chapter 9	applications, simple gear train - numericals, compound gear train - numerical	3	77
34	R2 – chapter 9	Mechatronics : Definition, Terminology and applications	3	80
35	R5 – chapter 20	**Unit 5** Description of primary and secondary manufacturing processes, Foundry – classification, casting - classification Sand casting - steps, pattern making, types of patterns, patterns allowance. Desirable properties of sand	2	82
36	R5 – chapter 20	gating system, defects in casting,	2	84
37	R2 – chapter 7	Welding- definition, classification, working principle of arc welding, working principle of gas welding - oxy acetylene welding, resistance welding. soldering, and brazing	3	87
38		Description of metal forming processes: rolling, forging and extrusion	3	90
39	R2 – chapter 5	Machine Tools: Basic working principles of Lathe,	2	92
40	R2 – chapter 5	Metal cutting operations: turning, facing, boring, thread cutting, drilling,	2	94
41	R2 – chapter 5	Milling Machines - milling operations	3	97
42	R2 – chapter 5	Drilling machine – Drilling machine operations Introduction to CNC	3	100

Reference Books:

1. "Mechanics of Materials", Ferdinand Beer , Jr., E. Russell Johnston , John Dewolf, McGraw Hill Publications, Sixth Edition, 2002.

2. "Elements of Mechanical Engineering", K.R. Gopalkrishna, Subhas Publications, Bangalore, 2008.
3. "An Introduction to Mechanical Engineering – Part I", Michael Clifford, Richard Brooks, Alan Howe, Andrew Kennedy, Stewart McWilliam, Stephen Pickering, Paul Shayer and Phillip Shipway, Hodder Education, 2009
4. "Mechatronics: A Multidisciplinary Approach", W Bolton, PHI, Fourth Edition, 2016.
5. "Elements of Manufacturing Processes", B.S.Nagendra Parashar and R.K. Mittal, PHI, 2011
6. "Basic Mechanical Engineering", Pravin Kumar, Pearson, 2013

QUESTION BANK

Unit 1

1. How is per capita income related to standard of living?
2. Write a brief note on oil crisis 1973
3. What are primary and secondary energy sources?
4. What are Conventional and non-conventional sources?
5. List various non conventional energy sources. Give their availability and relative merits.
6. List advantages and drawbacks of renewable and non renewable energy sources.
7. What is commercial energy?
8. Write a brief note on non-conventional energy sources with reference to Indian energy scenario.
9. Write a brief note on Indian constitutional policies with regard to renewable energy sources.
10. What is green house effect? Mention reasons and consequences.
11. Define green power.
12. What are the prospects of solar energy in India? List possible applications
13. What are the prospects of wind energy in India? List possible applications
14. What are the prospects of tidal energy in India? List possible applications
15. What are the prospects of wave energy in India? List possible applications
16. What are the prospects of biomass energy in India? List possible applications
17. What are the prospects of hydro electric energy in India? List possible applications
18. What are the prospects of micro hydro energy in India? List possible applications
19. Explain wind energy conversion systems.
20. Describe operation of a thermal power plant with a neat schematic
21. Describe operation of hydroelectric and nuclear power plants.
22. What is coal, what are the different types of coal?

UNIT 2

1. Explain with a schematic sketch the different parts of a (i) 2-stroke IC engine (ii) 4-stroke IC engine explaining the same with the help of the thermodynamic cycle.
2. Explain the working of four-stroke and two-stroke IC Engines running on petrol and diesel explaining the same with the help of the thermodynamic cycle.
3. What are the relative advantages and disadvantages of SI and CI engines?

4. Classify IC engines based on the nature of thermodynamic cycle and type of fuel used.

5. What are turbines?

6. Explain how steam turbines are classified and also list their applications.

7. What do you understand by compounding of turbines?

8. Define refrigeration and its principle.

10. Compare vapor compression and vapor absorption refrigeration techniques.

11. Explain any two properties of good refrigerant?

12. Define ton of refrigeration and COP?

13. What is the unit of refrigeration and explain?

14**.** Explain working principle of of Vapour compression and vapour absorption refrigeration units with neat schematic.

15. Define the following terms with respect to steam

Saturation temperature, latent heat of vapourisation, Quality of steam, Sensible heat, Specific volume of the steam, Degree of super heat, Amount of superheat, Enthalpy of wet, saturated and superheated steam, Internal latent heat and internal energy.

16. A steam at 10 bar and dryness 0.98 receives 140 kJ/kg at the same pressure . What is the final state of the steam?

17. Find the enthalpy of 1 kg of steam at 12 bar when a) steam is dry saturated, b) steam is 22% wet, and c) super heated at 250 °C. Use the steam table and assume the specific heat of the super heated steam as 2.25 kJ/kgK.

18. A mixture of saturated water and saturated steam at a temperature of 250 °C is contained in a closed vessel of 0.1 m^3 capacity. If the mass of saturated water is 2kg, find the mass of the steam in the vessel. Also find the pressure, specific volume, dryness fraction and the enthalpy of the mixture.

UNIT 3

1. List the engineering materials and give examples where they are used

List mechanical properties and describe them in brief.

2. If you are designing an airplane, what kind of material would you employ to build the craft? Explain what mechanical properties are desirable and why.

3. What is the need for mechanical testing of materials?

4. Explain briefly methods used to test ability of a material to withstand axial loading, resistance to abrasion and behaviour under sudden loading.

5. Discuss some of the characteristics and applications for metals and their alloys, ceramics, polymers, and composite materials.

6. With the help of neat sketch draw stress – strain curves, explain the tensile behaviour of mild steel by considering both engineering and true stress . What is hookes law and young's modulus

7. Explain the tensile behaviour of aluminium with the help of a tensile stress – strain curve. Highlight the calculation of proof stress in this curve

8. Explain shear strain by considering a square solid subjected to shear stress at all boundaries (Note: The body remains in equilibrium after the application of stress)

9. Explain Hooke's law for shear loading

10.Differentiate between engineering and true strain

11. Explain the different regions of a stress – strain curve for mild steel

12. A circular rod of diameter 16 mm and 500 mm long is subjected to a tensile force 40 kN. The modulus of elasticity for steel may be taken as 200 kN/mm^2. Find stress (correct to 2 decimal places)(in N/mm^2), strain (Correct to 5 decimal places) and elongation of the bar (in mm) (correct to 3 decimal places) due to applied load.

13. The bar shown in figure is tested in universal testing machine. It is observed that at a load of 40 kN the total extension of the bar is 0.280 mm. Determine the Young's modulus of the material in Gpa.

14. A reinforced concrete column of size 300 mm × 500 mm has 8 steel bars of 16 mm diameter as shown in the figure. If the column is subjected to an axial compressive force of 800 kN, find the stresses developed in steel and concrete.

15. A bar of length 1000 mm and diameter 30 mm is centrally bored for 400 mm, the bore diameter being 10 mm as shown in figure. Under a load of 30 kN, if the extension of the bar is 0.222 mm, what is the modulus of elasticity of the bar?

16. Two solid cylindrical rods AB and BC are welded together at B and loaded as shown. Knowing that the average normal stress must not exceed 175 MPa in rod AB and 150 MPa in rod BC, determine the smallest allowable values of d1 and d2

17. What is the difference between the elastic and plastic behavior of materials?

18. What are the approximate numerical values for the elastic modulus of steel, aluminum, copper and concrete?

19. How and why is the yield strength found using the 0.2% offset method?

20. What is Poisson's ratio? what is the poisson's ratio of rubber, steel, gold and cork ?

21. In what ways do tensile and shear stresses differ?

22. What is the factor of safety? When is the factor of safety too small? Can it be too large? what are the advantages of high and low factor of safety?

23. Discuss some of the trade-offs that an engineer would consider when deciding whether a design's factor of safety is too large or too small.

UNIT 4

1. Briefly explain classification of power transmission systems and list their applications

2. Explain velocity ratio and train value in belt and gear drives. Explain the ratio of belt tensions.

3. Explain how open and cross belt drives function. How is the length of the belt calculated?

4. What is the function of stepped cone pulley? Explain with a simple sketch.

5. What is the material used for belt. Define slip and creep of belts. Why it occurs? Explain

6. Why gear drive is called a positive type of power transmission?

7. State when the following types of gear drives are employed?

   i) Spur gears

   ii) Helical gears

   iii) Worm and worm wheel

iv) Rack and pinion

v) Bevel gears

8. Mention the different types of gear used for the following cases:

i. To obtain rotary motion from linear motion.

ii. To transmit power between two perpendicular shaft lying in the same plane.

iii. To obtain varying rate of speed in every revolution of the driven gear.

9. Which type of gearing system offers self locking? State the reason.

10. What are miter gears?

11. Differentiate between simple and compound gear trains

12. Two spur gears P and Q connect two parallel shafts that are 450 mm apart. Gear P runs at double the speed of gear Q. gear Q runs at 150 rpm in the counter-clockwise direction. If the circular pitch is given to be 20 mm, calculate the number of teeth on gear P and Q.

13. In a compound train of wheels, A, B, C and D have 15, 30, 20 and 40 teeth respectively. The wheel, B and C are keyed to the same spindle. If the wheel A runs at 400 rpm, find the speed of the wheel D. sketch the arrangement.

14. A simple train of wheel consists of successively engaging three wheels having number of teeth 40, 50, and 70 respectively. Find its velocity ratio. If the driving wheel having 40 teeth is rotating at 210 rpm, find the speed of the driven wheel.

15. Two parallel shafts are driven by a spur gear drive. The driving wheel runs at 120 rpm and the driven wheel runs at 180 rpm. If the number of teeth on the driving wheel is 100, find the number of teeth on the driven wheel and the velocity ratio.

16. A person riding a bicycle turns the pedal at the rate of 30 rpm. Find the rpm of the wheel if the number of teeth in the driving sprocket is 52 and that in the driven sprocket is 26.

17. A roller chain engages two sprockets. The driving sprocket has 8 teeth and turns at 120 rpm. Find the number of teeth on the driven sprockets if it turns at 40 rpm.

18. A v-belt drive is used to transmit a power of 9.5 kW at a speed of 250 rpm. The groove angle of the v-belt is given to be 40 degree. The mean diameter of the grooved pulley is 1100mm, and the angle of lap is 180 degree. Calculate the tension on each side of the belt.

19. Two parallel shafts 6m apart are provided with 300 mm and 400 mm diameter pulleys and are connected by a cross belt. The direction of rotation of the follower pulley is to be reversed by changing over to an open belt drive. How much length of the belt should be changed?

20. In a belt drive, the ratio of tensions maybe assumed as 2, and the slack side tension is 50 kg. If the speed and the diameter of the driven pulley are 200 rpm and 120 cm respectively, find the power transmitted.

21. In a belt driven system of power transmission, the driven pulley running at 500 rpm drives another pulley at 30cm in diameter at 760rpm. Find the diameter of the driving pulley.

22. In a cross belt drive the difference in tension between the tight side and slack side is 1200 N. if the angle of contact is 160 degree and co-efficient of friction is 0.28; find the tension in the tight and slack side.

23. An engine is driving a generator by means of a belt. The pulley on the driving shaft has a diameter of 55 cm and runs at 276 rpm. If the radius of the pulley on the generator is 15cm, find its speed in rpm.

24. The sum of diameters of two pulleys is 1000mm and the pulleys are connected by belt. If the pulleys rotate at 600 rpm and 1800 rpm, determine the diameter of each pulley.

25. Why one side of the belt is tight and the other side is slack?
26. Explain reverted gear train and epicyclic gear train.
27. Explain terminologies used to describe gear geometry.

UNIT 5

1. Bring out the differences between a pattern and Casting
2. Enumerate on different Pattern materials
3. What are the factors that influence selection of Pattern material?
4. List at least 5 different types of Patterns
5. Enumerate on different Pattern allowances
6. List and explain desirable characteristics of moulding sand
7. What are the main requisites of an ideal 'Gating System?'
8. With a neat sketch identify different parts of a Gating System
9. List and explain at least 5 different types of Casting defects
10. Enumerate on broad classification of welding processes and mention various welding processes under each category
11. With a schematic sketch explain Manual Metal Arc Welding process; List the welding accessories needed for Manual Metal Arc Welding process
12. What are the functions flux coating in coated electrodes
13. Give a brief account of the factors that influence selection of welding electrodes
14. Make a comparison between DC and AC welding
15. With neat sketches explain: i) Oxy acetylene welding outfit, ii) Gas welding torches
16. Enumerate of different types of Oxy – acetylene flames
17. Define soldering and brazing.
18. Explain the terms "Hot working' and 'Cold working'
19. Bring out the merits and limitations of Hot working
20. Bring out the merits and limitations of Cold working.
21. List and explain any five hot working processes
22. With a neat sketch explain Hot Rolling process
23. With a neat sketch explain various Metal forming processes. Forging, rolling and extrusion.
24. Enumerate on the following:
    a. Types of Machine tools commonly used in Industry
    b. Functions of Machine tools
25. With a neat sketch explain the Principle of working of a Lathe
26. Briefly explain the specifications of a Engine Lathe
27. Give a brief account of different principal parts of a Engine lathe
28. Enumerate on different parts of a carriage of a lathe
29. Briefly explain the role of a chuck in a lathe ; List the different types of chucks
30. With neat sketches explain the following lathe operations:

i) Plain turning; ii) Step turning; iii) facing

31. Draw a neat sketch of a single point cutting tool and label all the features
32. With neat sketches explain the following lathe operations:

    i. Thread cutting ; ii) Knurling ; iii) Chamfering

33. List any 5 types of drilling machine operations
34. With a neat sketch explain the working principle of a Milling machine
35. List any 5 types of Milling operations
36. Briefly describe the term 'Drilling' and enumerate on different types of drills
37. With neat sketches explain the following lathe operations: i) Boring; ii) Reaming; iii) Drilling
38. Differentiate between conventional machine tool and a CNC machine.

UE19EE101 - BASIC ELECTRICAL ENGINEERING (3-0-0-0-3)
Lesson Plan

No. of Hours: 42

Unit No.	Chapter Title / Reference Literature	Total hours	Session number	Cumulative session number	Topics to be covered
1	DC Circuits	10	1	1	Introduction to the Course, Network terminologies, Ohms' Law
			2	2	Concept of Voltage & Current Source, Kirchhoff's Laws, Concept of Open & Short Circuits
			3	3	Voltage & Current Division Rule & Numericals
			4	4	Mesh Analysis & Numericals
			5	5	Introduction to Thevenin's Theorem, Concept of Thevenin's Equivalent Circuit
			6	6	Numericals on Thevenin's Theorem
			7	7	Superposition Theorem
			8	8	Numericals on Superposition Theorem
			9	9	Concept of Star and Delta; Star- Delta Transformations
			10	10	Numericals on Star-Delta Transformations
2	Single Phase AC Circuits	9	1	11	Introduction to AC Circuits. Representation of Sinusoidal Waveform
			2	12	Concept of Phasor & Phasor diagram
			3	13	Response of R, L & C to Sinusoidal AC supply
			4	14	Analysis of RL series, RC series circuits
			5	15	Analysis of RLC series circuits; Power & Impedance Triangles
			6	16	Numericals on Series RL & Series RC circuits
			7	17	Concept of Admittance; Analysis of Parallel RL, RC & RLC circuits
			8	18	Numericals on Parallel Circuits
			9	19	Concept of Power factor Improvement
3	Three Phase Balanced Systems	8	1	20	Introduction to Three Phase AC Systems; Generation of Three Phase EMFs
			2	21	Balanced Star Connected Three Phase System & its features
			3	22	Balanced Delta Connected Three Phase System & its features
			4	23	Power Relations in Balanced Three Phase Systems & Numericals
			5	24	Numericals on Balanced Star Connected Three Phase System

			6	25	Measurement of power using two - wattmeter method
			7	26	Numericals on Two Wattmeter Method
			8	27	Numericals on Two Wattmeter Method
4	Electrical Machines	8	1	28	Electromagnetic Induction, Faraday's Law, Lenz's law, Self and Mutual Induced EMF's
			2	29	DC machines – Construction& Principle of Operation
			3	30	EMF equation of a DC generator& Types of DC Generators
			4	31	Torque Equation of a DC Motor & Concept of Back EMF
			5	32	Numericals on DC Motors
			6	33	Construction & Working Principle of a Single Phase Transformer
			7	34	EMF Equations of a Transformer & numericals
			8	35	Construction and working of a three-phase induction motor & Numericals
5	Electrical Installations	7	1	36	Components of LT Switchgear & Switch Fuse Unit (SFU)
			2	37	MCB, MCCB & ELCB
			3	38	Types of Wires and Cables
			4	39	Necessity of Earthing & its types
			5	40	Elementary calculations for energy consumption
			6	41	Types of Batteries
			7	42	Types of Batteries

Text Book:

1. Electrical and Electronic Technology- Hughes, Brown and Smith, Pearson Education,9th Edition 2008

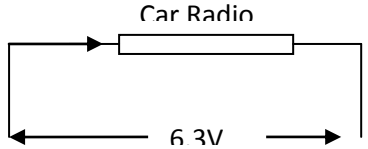
Reference Books*:*

1. Basic Electrical Engineering – D C Kulshreshta, Tata- Mc Graw-hill First Edition, 2009
2. Basic electrical Engineering – V N Mittle/ Arvind Mittle, 2nd edition, Tata- McGraw-Hill, 2007

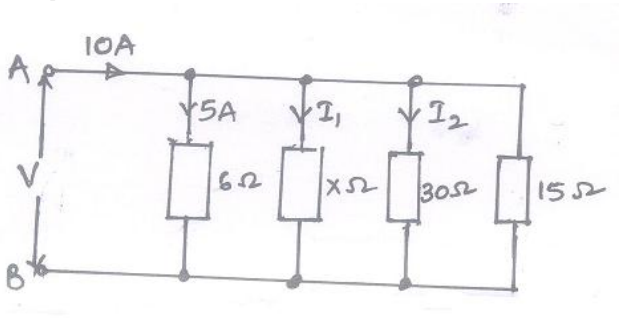
UE19EE101 - COURSE INFORMATION

UNIT I - DC CIRCUITS

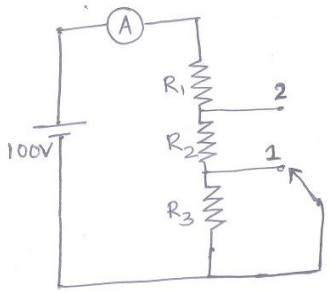
1. A 100W, 120V lamp is connected in series with another lamp of 40W, 120V and the combination is connected across 240V supply mains. Calculate the value of the resistance to be connected across the second lamp, so that each lamp may get the proper current at rated voltage.**[Ans: R = 240Ω]**
2. A current of 20A flows through two ammeters A and B joined in series. Across A the potential difference is 0.2V and across B it is 0.3V. Find how the same current will divide between A and B when they are joined in parallel.**[Ans: IA=12A;IB=8A]**
3. A car radio designed to operate from a 6.3V system uses 4.5A of current, as shown in fig (a) What resistance R should be placed in series with this radio if it is to be used in a 12.6V system? b) What should be the power rating of this resistance?**[Ans: R=1.4Ω; P=28.35W]**



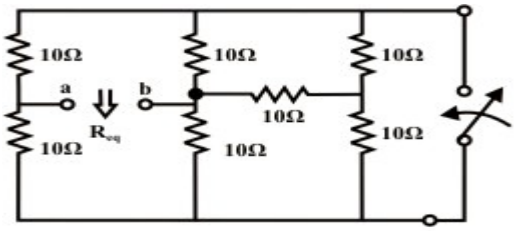
4. In the network shown in fig .calculate (a)the current in the other resistances,(b) the value of the unknown resistance X, and (c)the equivalent resistance between points A and B.**[Ans: I 30Ω = 1A; I 15Ω = 2A; X = 15Ω; I X = 2A; Req = 3Ω]**



5. In the circuit shown, the ammeter reads, 50 A, 70 A when the switch is in position 1 and 2 respectively, 25 A without switch. Find the value of resistors. **[Ans: R1=1.42Ω; R2 = 0.58Ω; R3 = 2Ω]**



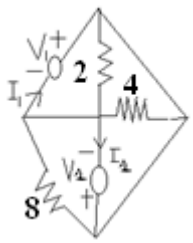
6. Find the value of R_{eq}, in the following circuit when the switch is CLOSED. **[Ans: R=8.75 Ω]**



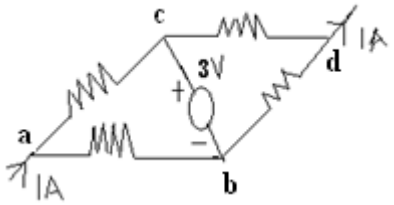
KCL and KVL

7. Two batteries A and B are connected in parallel and a load of 10Ω is connected across them. Battery A has an emf of 9V and internal resistance of 0.5Ω and B has an emf of 12V and internal resistance of 1Ω. Determine i) the magnitude and the direction of current flowing through load resistance, ii) current supplied by each battery and iii) p.d across the load resistance.**[Ans: 0.96A, 1.335A, 2.323A, and 9.68V]**

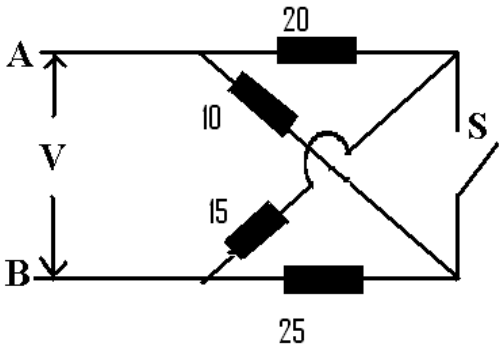
8. For the circuit shown find V1 and V2 and also the power dissipated in each of the resistors. Given I1 =5mA and I2 = 3mA. All resistances are in Kilo ohms. **[Ans: 9.412V, 41.78mW, 20.89mW, 10.44mW]**



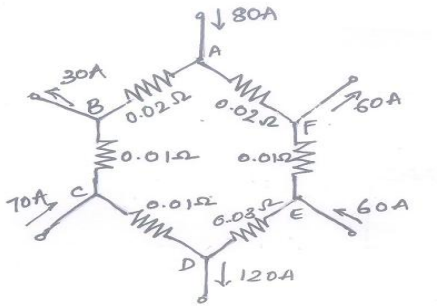
9. Compute all branch currents in the circuit shown. Every resistor is 1Ω. **[Ans:Iab = 2A; Icd = 2A]**



10. Find the value of Voltage V_{AB} , if the current through 15 Ω resistor is 3A when the switch S is (i) Closed and (ii) Open (All the values are in Ohms)**[Ans: 77v, 105v]**

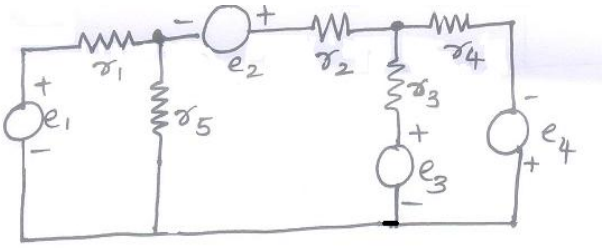


11. Find current in all branches of the network shown**[Ans: IAB = 41A]**

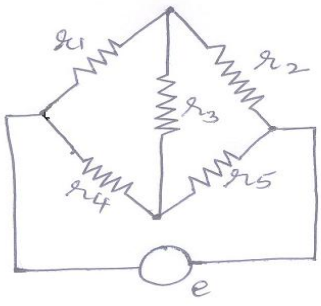


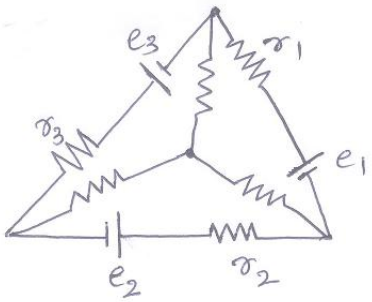
Mesh Analysis

12. Develop Mesh equations in the circuit shown

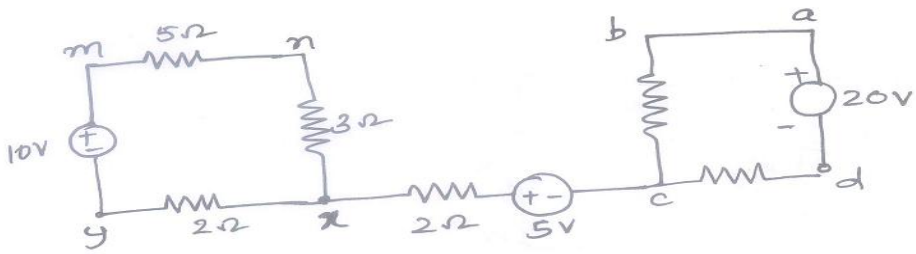


13. Develop mesh equations in the circuits shown

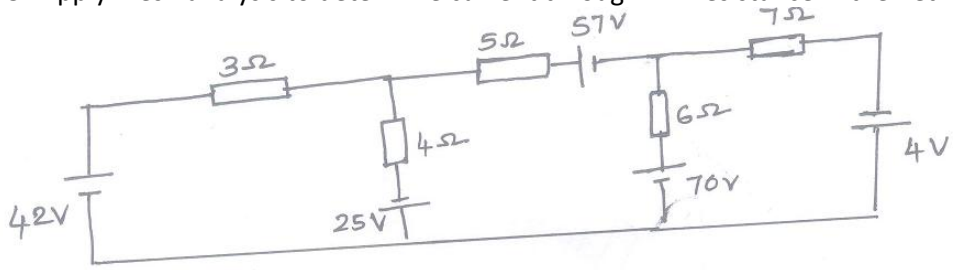




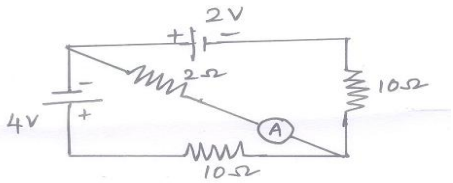
14. Find the voltage drop between terminals (y) and (d) in the network shown. Resistance between b and c = Resistance between c and d = 5Ω. **[Ans: Vyd = -13v]**



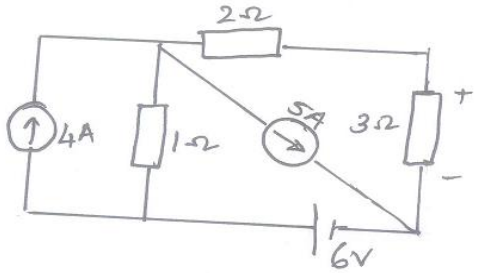
15. Apply mesh analysis to determine current through 7 Ω resistance in the network. **[Ans: 2A]**



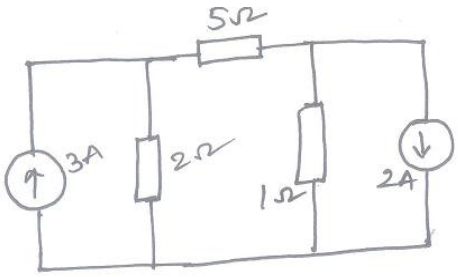
16. Find the ammeter current using mesh analysis**[Ans: -0.142A]**



17. Find the current through 3Ω resistor using loop-current analysis. **[Ans: 0.83A]**

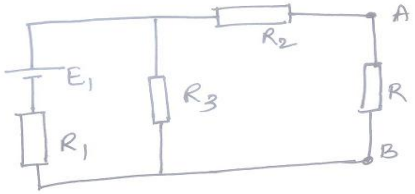


18. Determine the current through 5 Ω resistor in the circuit. **[Ans: 1A]**

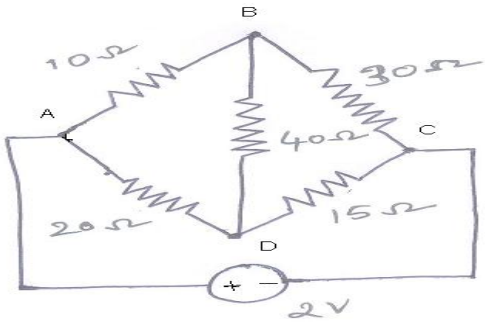


Thevenin's equivalent circuits

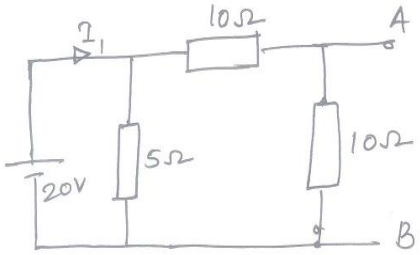
19. Find the ***Thevenin's*** equivalent, between A& B.



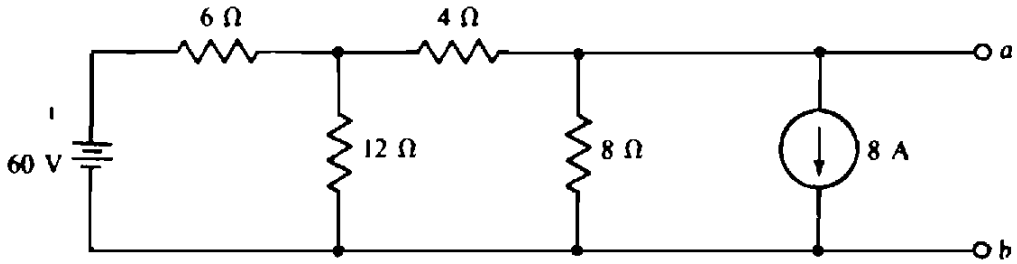
20. The resistances of the various arms of the bridge are given in fig .The battery has an e.m.f of 2.0 V and a negligible internal resistance. Determine the value and direction of current in BD by Thevenin's Theorem.**[Ans: I_{BD} = 11.41mA]**



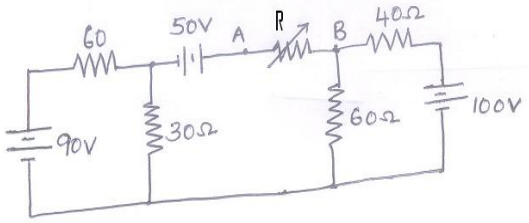
21. Draw Thevenin's equivalent circuit across terminals A-B in the circuit shown in fig, and hence find the current that would flow through a 2 Ω resistance when connected across the terminals A-B.**[Ans: V_{TH} = 10V, R_{TH} = 5Ω]**



22. Obtain the Thevenin's Equivalent between the terminals a & b in the circuit shown below:**[Ans: V_{TH} = -12V, R_{TH} = 4Ω]**

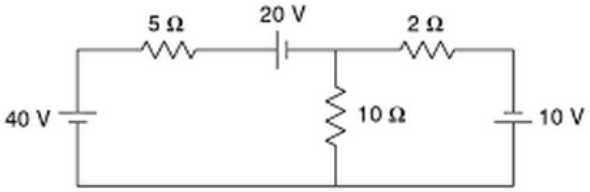


23. Using Thevenins Theorem, calculate the range of current flowing through the resistance R, when its value is varied from 6Ω to 36Ω.**[Ans: V_{TH} = 20v, R_{TH} = 44Ω; $I_{6\Omega}$ = 0.4A, $I_{36\Omega}$ = 0.25A]**

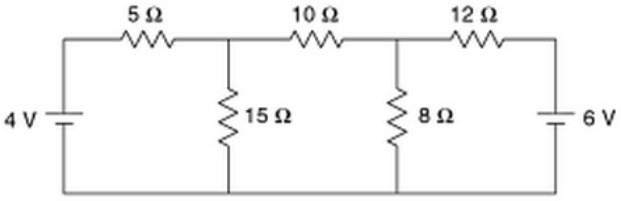


Superposition Theorem

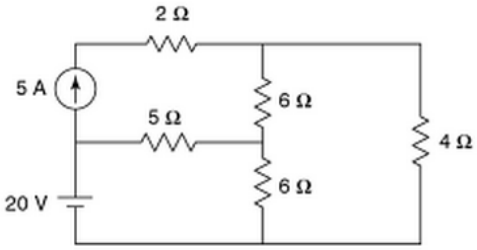
24. Find the current through the 2Ω resistor using Superposition Theorem. **[Ans:4.38A (→)]**



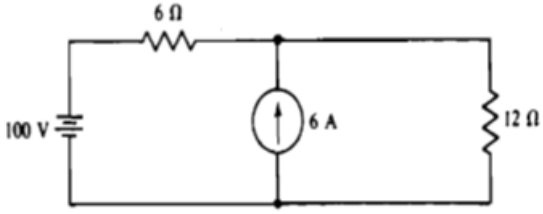
25. Find the current through the 8Ω resistor using Superposition Theorem. **[Ans:0.316A (↓)]**



26. Find the current through the 4Ω resistor using Superposition Theorem**[Ans:4.29A (→)]**

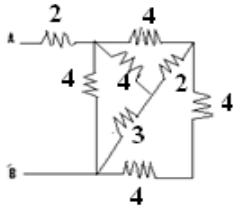


27. Use Superposition to find the power absorbed by 12Ω resistor in the circuit shown below **[Ans:685W]**

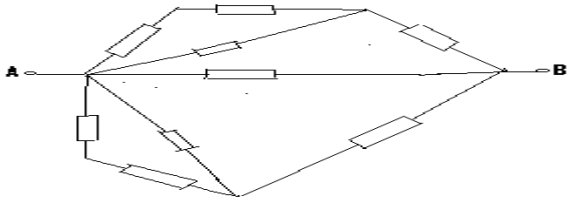


Star - Delta Conversions

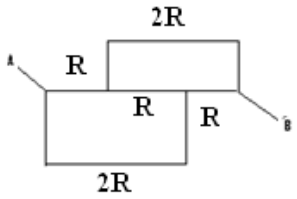
28. Determine the resistance between terminal A and B for the network shown. **[Ans:4.058Ω]**



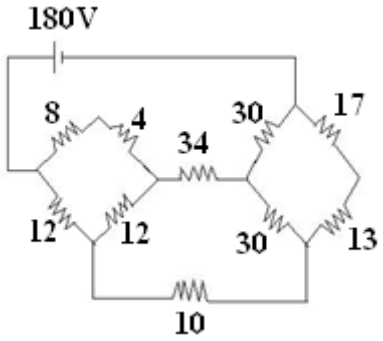
29. Find the equivalent resistance between the points A and B for the network shown using Y-Δ / Δ-Y transformations. All resistances are of R ohms.**[Ans:5R/11Ω]**



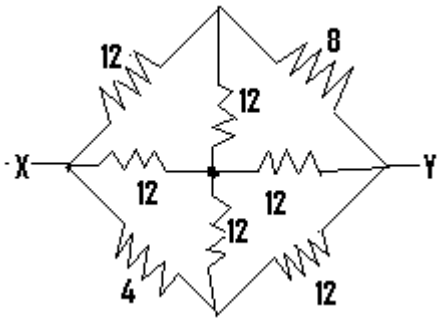
30. Using Y- Δ or Δ – Y transformation find the effective resistance between the terminals A and B.**[Ans:1.4R]**



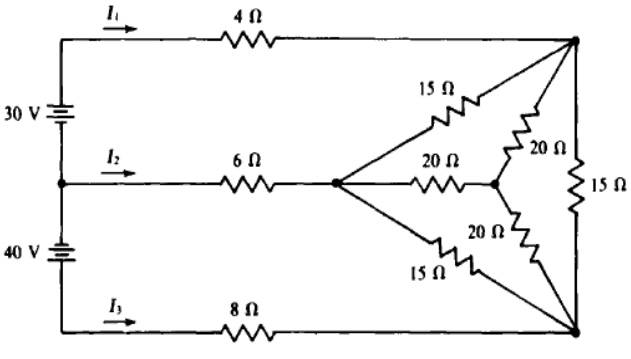
31. For the network shown find the current through 10 ohm resistor. **[Ans:4A]**



32. Find the equivalent resistance between the points X and Y for the circuits shown below. **[Ans:6.3Ω]**



33. Find the currents I_1, I_2, I_3 in the following circuit, by using *Delta to Star or Star to Delta Transformation.* **[Ans:0.87A, -2.29A, 1.42A]**



UNIT II – SINGLE PHASE AC CIRCUITS

Problems on Basic Sine wave

34. The maximum value of a sinusoidal alternating current of frequency 50Hz is 25 A. Write the equation for the instantaneous expression of current,. Determine its value at 3ms and 14 ms.**[ANS: i(3ms) = 20.23A; I(14ms) = -23.77A]**

35. A sinusoidal wave of frequency 50Hz has its maximum value of 9.2A. what will be its value at i) 0.002sec after passing through zero in positive direction. ii) 0.0045sec after the wave passes through positive maximum. Sketch the waveform of current showing the current value at the above time instants. **[ANS: i) i=5.4A; ii) i = 1.44A]**

36. Four single phase generators whose emf's can be represented by e1= 20sinωt, e2= 40sin(ωt+π/2), e3= 30sin(ωt-π/6), e4= 10sin(ωt-π/3) are connected in series. Find the resultant emf. Also find the maximum value of resultant emf and its phase angle relative to e2. **[ANS: e = 53.51 sin (wt+17.76); relative to e2 = 53.51∟72.24°]**

37. There are 3 conducting wires connected to a junction. The currents flowing into the junction in 2 wires are i1=10sin314t A and i2=15cos(314t - 45^{o})A. What is the current leaving the junction in the third wire? What is its value at t=0? **[ANS: i3 = 23.16 sin (wt+27); i3 at t=0 = 10.51A]**

RL series

38. Find the instantaneous expression for the current when a voltage represented by v= 283sin100πt is applied to a coil having R=50Ω and L= 0.159H. **[ANS: i = 3.98 sin (wt-45)]**

39. A choke coil is connected to a 240V ac supply. When the frequency of the supply is 50Hz, an ammeter connected in series with the choke reads 60A. On increasing the frequency of the supply to 100Hz, the same ammeter reads 40A. Calculate r and L of the coil. {**ANS: L = 8.21mH; R = 3.66Ω]**

40. When a resistor and an inductor in series are connected to a 240V supply, a current of 3A flows lagging 37^{0} behind the supply voltage, while the voltage across the inductor is 171V. Find the resistance of the resistor, and the resistance and reactance of the inductor. Find the power factor of the circuit. {**ANS: R = 33.37Ω; Rcoil = 30.52 Ω; XL = 48.14Ω, cos Φ = 0.79]**

RC Series

41. A series RC circuit, with R=4Ω,C=120μF is connected across 230V, 50 Hz supply. Calculate the current drawn by the circuit. Draw the phasor Diagram. Find the power factor. [**ANS: I = 8.57∟81.42°; p.f = 0.147]**

42. A capacitor is used in series with a tungsten- filament bulb rated at 500W,100V, so that it gives its rated illumination when connected to a 220V,50Hz supply. Calculate the value of the capacitance, current drawn by the supply. Find the power factor. [**ANS: C = 81.27 μF, I = 5A, p.f = 0.45]**

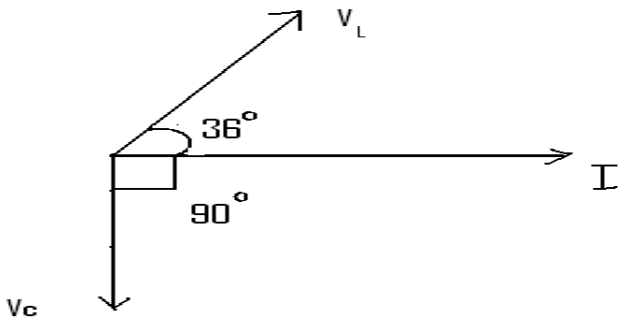
RLC Series

43. From the following phasor diagram, determine:

(i) Power Factor of the circuit

(ii) Reactive power in the circuit

(iii) Magnitude of supply voltage



Also, Redraw the phasor diagram by taking supply voltage as reference, mentioning all the voltages and current. Current phasor is 10 A , V_C is 6V and V_L is 10 V. [**ANS: p.f = 0.99 (lead), Q = 1.29VAR, V = 8.09V]**

44. A non-inductive resistor is connected in series with a coil and capacitor of 25.5μF. The current in the circuit is 0.4A and the potential difference across the non-inductive resistor is 20V, across the coil is 35V, across the capacitor is 50V and across the combination of non-inductive resistor and coil is 45V. Find the resistance and inductance of the coil. Also find the applied voltage, frequency and the power dissipated in the coil and the whole circuit. [**ANS: R = 50Ω, Rcoil = 25.11Ω, Lcoil = 0.266H, V = 34.22V, f=50Hz, P = 12W]**
45. A coil of power factor 0.6 is in series with a 100μF capacitor. When connected to a 50Hz supply, the potential difference across the coil is equal to the potential difference across the capacitor. Find the resistance and inductance of the coil. [**ANS: Rcoil = 19.09Ω, Lcoil = 81mH]**

RL Parallel

46. A parallel RL circuit has R=4Ω, X_L=3Ω. Obtain its series equivalent such that the series circuit draws the same current and power at a given voltage. [**ANS: R = 1.46Ω, X_L = 1.93Ω]**
47. The admittance of a circuit is (0.05-j0.08)mho. Find the values of the resistance and inductive reactance of the circuit if they are a) in parallel b) in series. [**ANS: R = 5.62Ω, X_L = 8.99Ω]**

RC Parallel

48. When a two element parallel circuit is connected across an ac source of frequency 50 Hz, it offers an impedance (10-j10)Ω. Determine the values of the two elements. [**ANS: R = 20Ω, C = 159.15μF]**
49. The terminal voltage and current for a parallel circuit are 141.4sin 2000t V and 7.07sin (2000t+36^0)A. Obtain the simplest two element parallel circuit, which would have the above relationship. [**ANS: R = 25Ω, C = 14.5μF]**
50. A resistor of 30Ω and a capacitor of unknown value are connected in parallel across a 110V, 50Hz Supply. The combination draws a current of 5A from the supply. Find the value of unknown Capacitance. This combination is again connected across a 110V supply of unknown frequency. It is now observed that the total current drawn from the mains falls to 4A. Determine the frequency of the supply. [**ANS: C = 98.4μF, f=23.37Hz]**

RLC parallel

51. Three circuit elements R=2.5Ω, X_L=4Ω and X_C=10Ω are connected in parallel, the reactances being at 50Hz. a) Determine the admittance of each element and hence obtain the input admittance. b) If this circuit is connected across a 10V, 50Hz AC source, determine the current in each branch and the

total input current. [**ANS: G = 0.4mho, Y_L = -j0.25 mho, Y_C = j0.1, Y = (0.4-j0.15) mho, I_R = 4∟0° A, I_L = 2.5∟-90° A, I_C = 1∟90° A, I = 4.3∟-20.56°A]**

52. A voltage of 200 V is applied to a pure resistor (R), a pure capacitor, C and a lossy inductor coil with resistance of 100 Ω, all of them connected in parallel. The total current is 2.45 A, while the component currents are 1.5, 2.0 and 1.2 A respectively. Find the total power factor and also the power factor of the coil. Also find the total active and reactive power. [**ANS: pf = 0.9(lag), pf of coil = 0.6 (lag), P = 443.7Watts, Q = 207.85VAR]**

Power factor Improvement

53. The power consumed in the inductive load is 2.5 kW at 0.71 lagging power factor .The input voltage is 230 V, 50 Hz. Find the value of the capacitor C which must be placed in parallel, such that the resultant power factor of the input current is 0.866 lagging. **[ANS: C = 62.28µF]**

UNIT III - THREE PHASE BALANCED SYSTEMS

Single Star Load

54. A balanced three phase load consists of three coils, each of 4Ω resistance and 0.02 H inductance. Determine the total active power when the coils are connected in star, if supply voltage is 400 V, 50 Hz. **[Ans: P = 11.8KW]**

Single Delta Load

55. A balanced three phase load consists of three coils, each of 20Ω resistance and 0.4 H inductance. Determine the total active power and reactive power when the coils are connected in delta, if the supply voltage is 440 V,50- Hz. **[Ans: P = 2.687KW; Q=8.421KW]**

Extra Problems

56. A balanced 3Φ, star connected load of 100KW takes a leading current of 80A when connected to a 3Φ, 1.1KV,50Hz supply. Find the resistance, impedance and the capacitance of the load per phase. Also calculate the power factor of the load. **[Ans: Zph = 7.937∟-49°; Rph = 5.2Ω; C=532µF; cos Φ=0.656(lead)]**

57. A balanced 3Φ star connected load is supplied from a symmetrical 3Φ 400V system. The current in each phase is 30A and lags by 30^o behind the voltage. Find i) impedance in each phase ii) total power drawn. Draw phasor diagram. **[Ans: Zph = 7.698KW; P = 18KW]**

58. A 3Φ delta connected load, each phase has a impedance of (25+j40)ohms. The load is fed from the secondary of a 3Φ star connected transformer which has phase voltage of 240V. Draw the circuit diagram and calculate: i) current in each phase of the load, ii) voltage across each phase of the load, iii) current in the transformer secondary winding, iv) power supplied by the load.

59. A balanced delta connected load consumes 2 KW of power when connected to a three phase, 400 V, 50Hz supply. The same load when connected to a three phase 230 V,50 Hz supply, draws a current of 2 A at lagging power factor. Determine the load power factor and resistance and inductance per phase. **[Ans: pf = 0.829(lag), Rph = 165.12Ω, Lph = 0.354H]**

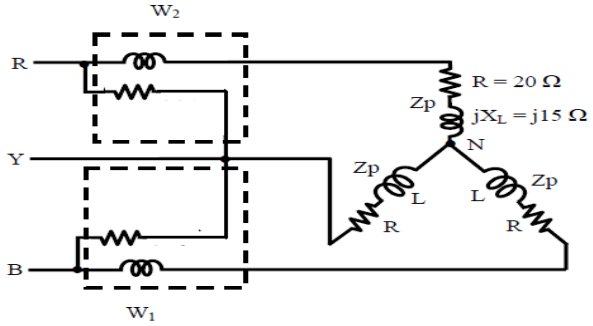
60. The load connected to a three phase supply comprises three similar coils connected in star. The line current is 25 A, the real and apparent powers are 11KW, 20 KVA. Find the line voltage, resistance and reactance of each coil. If the coils are connected in delta find the line current and power taken. **[Ans: V_L = 461.88V, Rph = 5.86Ω, Xph = 8.9Ω, in delta – I_L = 75A, P = 33KW]**

Wattmeter Method

61. In a balanced three phase system, power is measured by two wattmeter method. The ratio of two readings of wattmeter are found to be 2:1. Determine the power factor of the system. **[Ans: pf = 0.5]**

62. The power input to a synchronous motor is measured by two wattmeters both of which indicate 50kW. If the power factor of the motor be changed to 0.866 lead. Determine the readings of the two wattmeters the total input power remaining the same. Draw the phasor diagram for the second condition of the load. **[Ans: W_1 = 33.32KW, W_2 = 66.68KW]**

63. Calculate the readings of the two wattmeters (W_1&W_2) connected to measure the total power for a balanced star-connected load shown in Fig, fed from a three-phase, 400 V balanced supply with phase sequence as R-Y-B. Also find the readings of meters if they are connected in delta. **[Ans: W_1 = 1.59KW, W_2 = 4.034KW; In delta W_1 = 4.44KW, W_2 = 11KW]**



64. A 3- phase, Y-connected, balanced load with a lagging power factor is supplied at 400 V (between lines). A wattmeter when connected with its current coil in the R-line and voltage coil between R and Y lines gives a reading of 6kW. When the same terminals of the voltage coil are switched over to Y- and B-lines, the current coil connections remaining the same, the reading of the wattmeter remains unchanged. Calculate the line current and power factor of the load. Phase sequence is RYB. **[Ans:I_L = 30A; pf = 0.866(lag)]**

UNIT IV - BASICS OF ELECTRICAL MACHINES

DC machines

65. A 4 pole, wave wound generator having 40 slots and 10 conductors placed per slot. The flux per pole is 0.02 wb. Calculate the generated emf when the generator is driven at 1200 rpm. **[Ans: E_g = 320V]**
66. A 4-pole dc motor has a wave wound armature with 594 conductors. The armature current is 40A and flux per pole is 7.5mwb. Calculate the torque developed by the motor.**[Ans: T = 56.72Nm]**
67. A 25kw, 250V, dc shunt generator has armature and field resistances of 0.06ohm and 100ohm respectively. Determine the total armature power developed when working (1) as a generator delivering 25 kw output and (2) as a motor taking 25kw.
68. A four pole generator with wave wound armature has 51 slots, each having 24 conductors. The flux per pole is 0.01 Wb. AT what speed must the armature rotate to give an induced emf of 220V? What will be the emf developed if the winding is lap connected and the armature rotates at the same speed? **[Ans: N = 540rpm ; E_g = 110V]**

Three phase induction motors

69. A 3 ϕ 4 pole 50 hz induction motor runs at 1460 r.p.m. find its percentage slip. **[Ans: %S = 2.66%]**
70. A 12 pole 3 ϕ alternator driven at speed of 500 r.p.m. supplies power to an 8 pole 3 ϕ induction motor. If the slip of motor is 0.03p.u, calculate the speed. **[Ans: N = 727.5rpm]**
71. A 3-ϕ 4 pole induction motor is supplied from 3ϕ 50Hz ac supply. Find
    (1) synchronous speed
    (2) rotor speed when slip is 4%
    (3) the rotor frequency when runs at 600r.p.m.

[Ans: N_s = 1500rpm ; N = 1440rpm ; f_r = 30Hz]

72. A 12 pole 3-ϕ alternator is coupled to an engine running at 500r.p.m. If it supplies a 3ϕ induction motor having full speed of 1440r.p.m., Find the percentage slip, frequency of rotor current and no. of poles of rotor. **[Ans: %S = 4% ; f_r = 2Hz ; P = 4]**

Transformer

73. A 50 Hz power transformer has 1000 primary turns and 100 secondary turns. The CS area of the core is 6 sq cm and the maximum flux density while in operation is 10,000 Gauss. Calculate turns per volt for the primary and secondary winding. **[Ans: 0.133V/turn]**
74. A transformer with 40 turns on the high voltage winding is to be used to step down the voltage from 240V to 120V. Find the number of turns in the low voltage in the low voltage winding.**[Ans: N_2 = 20]**
75. A single phase transformer has 50 primary and 1000 secondary turns. Net cross sectional area of the core is 500 cm2. If the primary winding is connected to 50 Hz supply at 400 V, Calculate the value of maximum flux density on core and the emf induced in the secondary.

    [Ans : B_m= 0.721T ; E_2 = 8000V]
76. A transformer supplies a load of 32A at 415V. If the primary voltage is 3320V,find the following:
    a. Secondary volt ampere
    b. Primary current
    c. Primary volt ampere.

    Neglect losses and magnetizing current.

    [Ans: Secondary VA = 13.28KVA ; I_1 = 4A ; Primary VA = 13.28KVA]
77. A 250KVA, 11000/415V, 50Hz single phase transformer has 80 secondary turns. Calculate
    i) Rated primary and secondary currents
    ii) Number of Primary turns
    iii) Maximum value of flux
    iv) Voltage induced per turn

    [Ans: I_1 =22.72A ; I_2 = 602.41A ; N_1 = 2121 turns ; Max. Flux = 23.36mWb ; V/turn = 5.1875V/turn]
78. The primary winding of a transformer is connected to a 240V, 50Hz supply. The secondary winding has 1500 turns. If the maximum value of the core flux is 2.07mWb, determine
    i) Secondary Induced EMF
    ii) Number of Primary Turns
    iii) Net cross sectional area of the core if maximum flux density is 0.465T

    [Ans: E_2 = 689.31V ; N_1 = 522 turns ; A = 44.52cm^2]