Question Bank for 2022-2023

University of Salahaddin / College of Engineering

Engineering Analysis

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1- Solve the DE $xy=(1-x^2)\frac{dy}{dx}$; $\text{given } y=1 \text{ when } x=0$

2- Solve $xy^3 dy = (x^4 + y^4) dx$

3- Solve $x.dy - y.dx = 0$

4- Solve $\sinh(x).\sinh(y) + \cosh(x).\cosh(y).y' = 0$

5- Solve $\cos(x+y) + (3y^2 + 2y + \cos(x+y)).y' = 0$

6- Solve $(\cos \omega x + \omega.\sin \omega x)dx + e^x dy = 0$

7- Solve $\left[cosx \cdot \tan y + \cos(x+y)\right]dx + \left[sinx \cdot \sec^2 y + \cos(x+y)\right]dy = 0$

8- Solve $2xy.y' = x^2 + y^2$

9- Solve $(1 + y^2 \sin 2x)dx - 2y\cos^2 x\,dy = 0$

10- Solve $y' + 2.\sin 2x.y = 2e^{\cos 2x}$

11- Solve $y' = 6(y - 2.5)\tanh(1.5x)$

12- Solve $y'.\cos^2 x + 3y = 1$

13- Solve $y' + 2y = 4\cos 2x$

14- Solve $y' + y = y^3$

15- Solve $y' = 5.7y - 6.5y^2$

16- A tank initially contains **50** gallons of brine, with **30** lb of salt in solution. A brine of 1/6 pounds of salt per gallon of water is added to the tank at the rate of **3** gallons per minute. The mixture in the tank is kept uniform by stirring. Brine runs out (drained) from the tank at the same rate .

Find the amount of salt in the tank at any time t?

17- A tank initially contains **60** gallons of brine, with **20** lb of salt in solution. A brine of 1/10 pounds of salt per gallon of water is added to the tank at the rate of **5** gallons per minute. The mixture in the tank is kept uniform by stirring. Brine runs out (drained) from the tank at the rate **2** gallons per minute.

Find;

a) The amount of salt in the tank at any time t?
b) Time of overflow?
c) Amount of salt at overflow?

18- A boiling solution (100^{o} C) is set in room of temp (20^{o} C), after 5 min the solution cooled to (60^{o} C).

When will the temp. of the solution be (22^{o} C).

19- In winter season, the daytime temperature in a particular building is maintained at 70^{o}F. The heating shut off at 10 P.M. and turned on at 6 A.M.

On a certain day the temperature inside the building at 2 A.M. was found to be 65^{o}F.

The outside temperature was 50ºF at 10 P.M. and had dropped to 40ºF by 6 A.M.
What was the temp. inside the building when the heat turned on at 6 A.M.

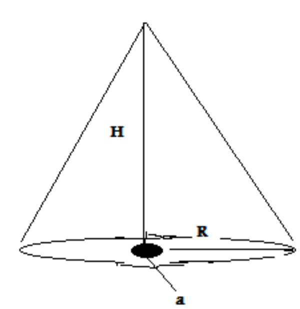
20- A tank contains 8 L (liters) of water in which is dissolved 32 g (grams) of chemical. A solution containing 2 g/L of the chemical flows into the tank at a rate of 4 L/min, and the well-stirred mixture flows out at a rate of 2 L/min.

a- Determine the amount of chemical in the tank after 20 minutes.

b- What is the concentration of chemical in the tank at that time?

21- A cold juice initially at 35̊ F warms up to 40̊ F in 3 min while sitting in a room of temperature 70̊ F. How warm will the juice be if left out for 20 min?

22- Suppose we have an inverted conical tank with height H and radius R, suppose fluid is flowing through a hole in the bottom with cross sectional area a with velocity given by $V(t) = k\,[2\,g\,h(t)]^{1/2}$; where h(t) is the height of fluid in the tank.



Find the time required to empty the tank.

23- Find the lateral displacement of a hinged-hinged column (or hinged-hinged beam) of length (L) subjected to an axial load (P) and a uniform lateral distributed load (W) .

24- Find the Buckling of a hinged-hinged column

25- Find the lateral displacement of a hinged-hinged column (or hinged-hinged beam) of length (L) subjected to an axial load (P) and a uniform lateral distributed load (W).

26- Solve $y'' - 9y = 0$

27- Solve $4y'' + y = 0$

28- Solve $y'' + y = 0$

29- Solve $4y'' + y' = 0$

30- Solve $y'' + y' + y = 0$

31- A spring with a mass 2kg has natural length 0.5m. A force of 25.6 N is required to maintain it stretched to a length of 0.7m. If the spring is stretched to a length of 0.7m and then released with **initial** velocity zero, find the position of the mass at any time t.

32- Solve the differential equation:

$$y'' + 3y' + 2y = x^2 \text{...........}(1)$$

33- Solve the differential equation:

$$y'' - 6y' + 9y = 6e^{3x}$$

34- Solve the differential equation:

$$y'' + y' + y = x^2 + e^x$$

35- Solve the differentail equ:

$$y'' - 2y' - 3y = e^{2t} + 3t^2 + 4t - 5 + 5\cos(2t)$$

36- Solve the differentail equ:

$$y'' + 9y = -4x\sin(3x)$$

37- *Write down the form of the particular solution to:*

$$\boxed{y'' + y' + y = G(t)}$$

For the following G(t)'s:

$$G(t) = 16e^{7t} \cdot \sin(10t)$$

$$G(t) = (9t^2 - 103t)\cos t$$

38- Write down the form of the particular solution to the following G(t):

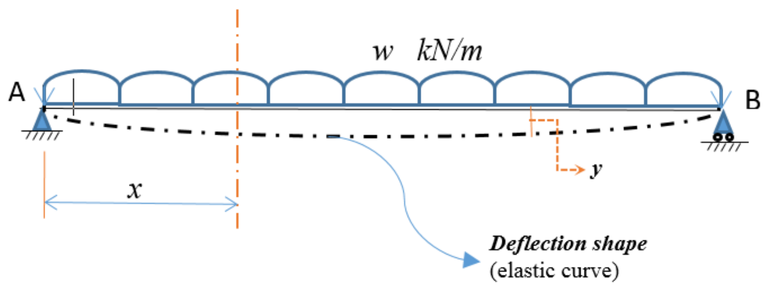
$$y'' + y' + y = G(t)$$

$$G(t) = e^{-2t}(3 - 5t)\cos 9t$$

$$G(t) = 4\cos(6t) - 9\sin(6t)$$

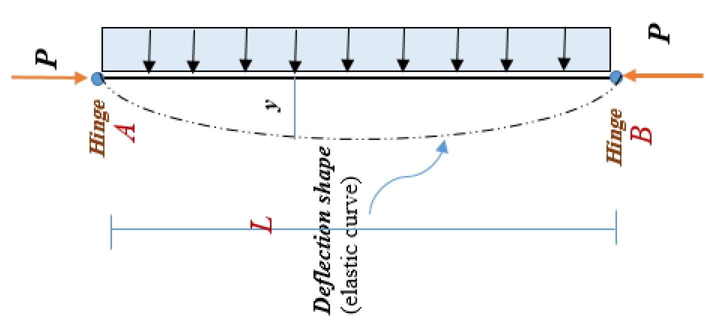
$$G(t) = -2\sin t + \sin(14t) - 5\cos(14t)$$

39- *Find the maximum deflection of simply supported beam subjected to uniform distributed load:*

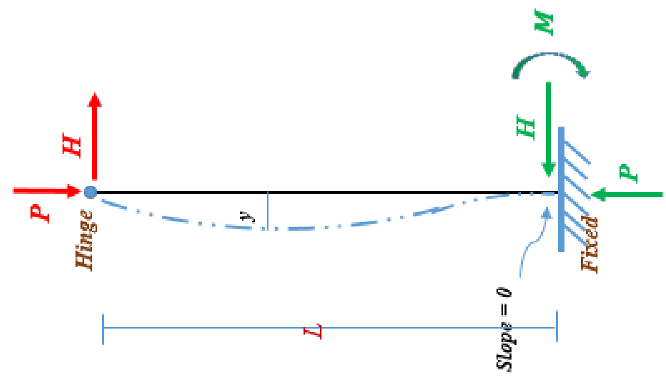


40- *Buckling of the hinged-hinged columns*

41- *Find the lateral displacement of a hinged-hinged column (or hinged-hinged beam) of length (L) subjected to an axial load (P) and a uniform lateral distributed load (W) .*



42- *Buckling of the fixed-hinged columns*



43- Solve; $L\,(5\,e^{-3t}\,\sin$

44- So $L\left[2\,e^{3t}\,(4\cos 2t - 5\sin 2t)\right]$

45- Solve;

$$L\left[3\,e^{-2t}\,(\sinh 2t - 2\cosh 2t)\right]$$

46- Use the Laplace transform of the **Second** derivative to derive:

$$L(\sin at) = \frac{a}{s^2 + a^2}$$

47- Use the Laplace transform of the **Second** derivative to derive:

$$L(\sinh at) = \frac{a}{s^2 - a^2}$$

48- Use the Laplace transform of the **Second** derivative to derive:

$$L(\cosh \; at) = \frac{s}{s^2 - a^2}$$

49- Use the Laplace transform of the Second derivative to determine the Laplace of:

$$L\{t \cdot \cos \; \omega t\}$$

50- Solve; $\mathcal{L}^{-1}\left\{\dfrac{4s-3}{s^2-4s-5}\right\}$

51- Solve; $L^{-1}\left\{\dfrac{2(s+1)}{s^2+2s+10}\right\}$

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52- Solve; $L^{-1}\left\{\dfrac{7s+13}{s(s^2+4s+13)}\right\}$

53- Determine the following inverse Laplace transforms

$$\mathcal{L}^{-1}\frac{(s+3)}{s(s-1)(s+2)}$$

54- Determine the following inverse Laplace transforms

$$\mathcal{L}^{-1}\frac{(s-1)}{s^2+2s-8}$$

55- Determine the following inverse Laplace transforms

$$\mathcal{L}^{-1}\frac{3s+7}{s^2-2s+5}$$

56- Determine the following inverse Laplace transforms

$$\mathcal{L}^{-1}\frac{e^{-7s}}{(s+3)^3}.$$

57- Use Laplace transforms to solve the differential equation

$$\frac{d^2y}{dx^2}+6\frac{dy}{dx}+13y=0 \text{ , } \textit{given that when } x=0,\ y=3 \textit{ and } \frac{dy}{dx}=7.$$

58- Use Laplace transforms to solve the differential equation

$$\frac{d^2y}{dx^2}-7\frac{dy}{dx}+10y=e^{2x}+20\text{, } \textit{given that when } x=0,\ y=0 \textit{ and } \frac{dy}{dx}=-\frac{1}{3}.$$

59- Use Laplace transforms to solve the differential equation

$$\frac{d^2y}{dx^2}+16y=10\cos 4x \quad \text{, given that when } y(0)=3 \quad \text{and} \quad y'(0)=4$$

60- Use the convolution of the Laplace transforms to solve the differential equation:

$$\frac{dy}{dx}-ay=e^{ct}, \text{ at } y(0)=0$$

61- Find the inverse of the Laplace transform using Convolution theorem for function:

$$H(s)=\frac{2s}{(s^2+1)^2}$$

62- Use the convolution of the Laplace transforms to solve the differential equation:

$$\boldsymbol{y''+2y'+2y=\sin\alpha t} \qquad \boldsymbol{y(0)=0}$$

$$\boldsymbol{y'(0)=0}$$

63- Apply convolution theorem to evaluate:

$$L^{-1}\left\{\frac{1}{s^2(s-1)}\right\}$$

64- Apply convolution theorem to evaluate:

$$L^{-1}\left\{\frac{s}{(s^2+4)^2}\right\}$$

65- Apply convolution theorem to evaluate:

$$L^{-1}\left\{\frac{1}{s(s^2+4)^1}\right\}$$

66- Apply convolution theorem to evaluate:

$$L^{-1}\left\{\frac{1}{(s+a)(s+b)}\right\}$$

67- Determine the Fourier series for the periodic function of period 2π

$$f(t) = \begin{cases} 0, & \text{when } -\pi < t < 0 \\ 1, & \text{when } \quad 0 < t < \frac{\pi}{2} \\ -1, & \text{when } \quad \frac{\pi}{2} < t < \pi \end{cases}$$

68- Determine the Fourier series for the function

$$f(x) = \begin{cases} -2, & \text{when } -\pi < x < -\frac{\pi}{2} \\ 2, & \text{when } -\frac{\pi}{2} < x < \frac{\pi}{2} \\ -2, & \text{when } \quad \frac{\pi}{2} < x < \pi. \end{cases}$$

69- Deduce the Fourier series for the function $f(\theta)=\theta^2$ in the range 0 to 2π.

70- Show that the Fourier series for the function $f(x)=x$ over the range $x=0$ to $x=2\pi$

71- Find the Fourier series for the function $f(x)=x+\pi$ within the range $-\pi < x < \pi$.

72- Determine the half-range sine series for the function defined by:

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

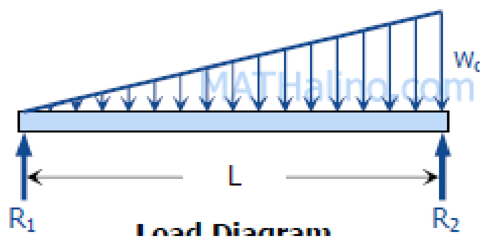
73- Obtain (a) the half-range cosine series and (b) the half-range sine series for the function

$$f(t)=\begin{cases} 0, & 0 < t < \dfrac{\pi}{2} \\ 1, & \dfrac{\pi}{2} < t < \pi \end{cases}$$

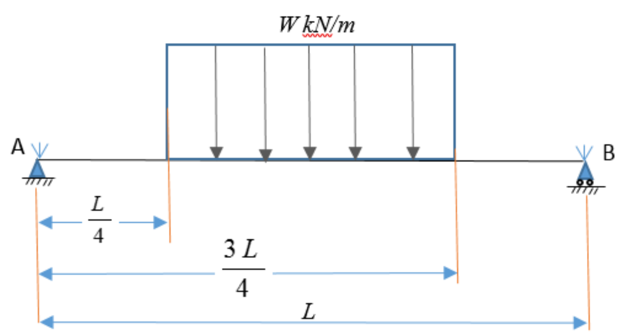
74- Find the half-range Fourier cosine series for the function $f(x)=x^2$ in the range $0 < x < 3$.

75- A beam of length L is simply supported at its ends and uniformly loaded by a load w. Find the deflection of the beam using Fourier series method.

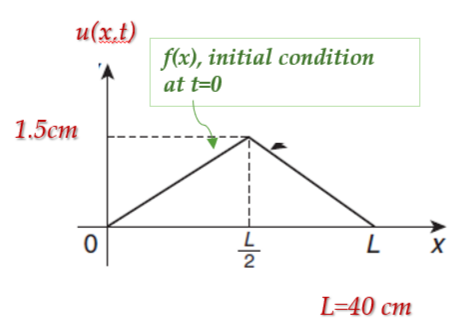
76- For the beam and loading shown, find the deflection by Fourier series method.



77- For the beam and loading shown, find the equation of the deflection by Fourier Series method, then find max. deflection.



78- An elastic string is stretched apart. Its center point is displaced 1.5 cm from its position of rest at right angles to the original direction of the string and then released with zero velocity. Determine the subsequent motion u(x, t) by applying the wave equation: with $c^2 = 9$.



79- A metal bar, insulated along its sides, is 1 m long. It is initially at room temperature of 15°C and at time t = 0, the ends are placed into ice at 0◦C. Find an expression for the temperature at a point *P* at a distance *x* m from one end at any time *t* seconds after *t* = 0.

80- : let a > 0, compute the FT of

$$f(x) = \begin{cases} e^{-ax} & x \geq 0 \\ e^{ax} & x \leq 0 \end{cases}$$