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| University of Salahaddin ‐ Hawler | | **ZANCOARM** |
| College of Engineering | |
| Department of Mechanical Engineering | |
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Problems on

AppliedEngineering Analysis

Academic Year 2021 – 2022

Senior Students (3rd Year)

Lecturer: Mahde A. Molan

Homogenous and In-Homogenous Linear Equations of Second Order

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| *Pr.1* | *Solve the following Homogenous Differential Equation:*  *y'' + 5 y' + 4 y = 0 y(0) =1 , y'(0)=-7* |
| *Pr.2* | *Solve the following Homogenous Differential Equation:*  *y'' + 2 y' + 5 y = 0 y(0) =4 , y'(0)=6* |
| *Pr.3* | *Solve the following Homogenous Differential Equation:*  *y'' - 4 y' + 4 y = 0 y(0) =4 , y'(0)=5* |
| *Pr.4* | *Find the general solution of the following second order linear homogeneous equations*  *y'' + 2y' + 5y = 0* |
| *Pr.5* | *Find the general solution of the following second order linear homogeneous equations*  *y'' + 2.6 y' + 1.69y = 0* |
| *Pr.6* | *Given the second order homogeneous differential equation:*    *Where w is a constant, show that its solution may be expressed as:*  *V = 7 cosh wt +3 sinh wt*  *Given the boundary conditions that when t =0, V =7 and* |
| *Pr.7* | *A spring-mass-dashpot system consists of a 10-kg mass attached to a spring with spring constant k=100 N/m; the dashpot has damping constant γ = 7 kg/s: At time t = 0, the system is set into motion by pulling the mass down 0.5 m from its equilibrium rest position while simultaneously giving it an initial downward velocity of 1 m/s. Solve systems equation, if it's differential equation be y'' + 0.7y' + 10y = 0* |
| *Pr.8* | *Solve the following linear homogeneous differential equation:*  *y''-4y'+6y=0 when y(0)=1, y(1)=13.6* |
| *Pr.9* | *Solve the following linear homogeneous differential equation:*  *2y''-2y'+1y=0 & y(0)=1, y'(0)=2* |
| *Pr.10* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''-2y'-3y=6* |
| *Pr.11* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+5y'+6y=2t* |
| *Pr.12* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+5y'-9y=cos2t* |
| *Pr.13* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+5y'-9y =t2* |
| *Pr.14* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+5y'-9y =e4t* |
| *Pr.15* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''-2y'+y =et* |
| *Pr.16* | *Solve of the following Inhomogeneous Linear Second Order Equation:*  *y''+y'-12y =4e2t y(0)=7 and y'(0)=0* |
| *Pr.17* | *Without using Laplace transforms, solve the following differential equations:* |
| *Pr.18* | *Without using Laplace transforms, solve the following differential equation:* |
| *Pr.19* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''-2y' =t+2et* |
| *Pr.20* | *Solve of the following Inhomogeneous Linear Second Order Equation:*  *y''+4y =3cos2t y(0)=0 and y'(0)=1* |
| *Pr.21* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+10y' +16y=80* |
| *Pr.22* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''-5y' +6y=3t+3* |
| *Pr.23* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+3y' -4y=-8t-6* |
| *Pr.24* | *Find the general solution of the following Inhomogeneous Linear Second Order Equation:*  *y''+3y' -10y= 4e3t + 2* |

***Laplace Transforme***

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| Pr.25 |  |
| Pr.26 |  |
| Pr.27 |  |
| Pr.28 |  |
| Pr.29 |  |
| Pr.30 | Find the Laplace transforms of:  6 sin 3t − 4 cos 5t |
| Pr.31 | Find the Laplace transforms of:  2 cosh 2θ − sinh 3θ. |
| Pr.32 | Determine the Laplace transforms of:  cosh2 3x. |
| Pr.33 | Determine the Laplace transforms of:  sin2 t |
| Pr.34 | Find the Laplace transform of:  3 sin (ωt +α), where ω and α are constants. |
| Pr.35 |  |
| Pr.36 |  |
| Pr.37 |  |
| Pr.38 |  |
| Pr.39 |  |
| Pr.40 |  |
| Pr.41 |  |
| Pr.42 |  |
| Pr.43 |  |
| Pr.44 |  |
| Pr.45 | Solve the following pairs of simultaneous differential equations: |
| Pr.46 | Use partial fractions to find the inverse Laplace transforms of the following functions: |
| Pr.47 | Use partial fractions to find the inverse Laplace transforms of the following functions: |
| Pr.48 |  |
| Pr.49 |  |
| Pr.50 |  |
| Pr.51 |  |

***Interpolation***

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| Pr.52 | The upward velocity of a rocket is given as a function of time in the following table:   |  |  | | --- | --- | | (s) | (m/s) | | 0 | 0 | | 10 | 227.04 | | 15 | 362.78 | | 20 | 517.35 | | 22.5 | 602.97 | | 30 | 901.67 |   Determine the value of the velocity at *t=16* sec. using the linear & quadratic interpolation |
| Pr.53 |  |
| Pr.54 |  |
| Pr.55 | Railroad freight traffic measured in billions of ton-miles since 1965 is presented in tabular form. (Source: Assoc. of American Railroads)    Estimate the amount of traffic in the years 1976 and 2000, using the second order Newton Divided Deference Interpolation |
| Pr.56 | Ex: The field strength of the earth's gravitational field *g* diminishes with distance *h* from the surface of the earth. The following table shows the field strength at several distances***:***    Find the Lagrange interpolating polynomial *f*1(*h*) which passes through the first two data points and the Lagrange interpolating polynomial *f*2(*h*) which passes through the last three data points. |
| Pr.57 | The relation between the coefficients of thermal expansion vs. temperature data is given in the table below:   |  |  | | --- | --- | | Temperature, | Thermal Expansion Coefficient, | | 80 | 6.47 | | 0 | 6.00 | | –60 | 5.58 | | –160 | 4.72 | | –260 | 3.58 | | –340 | 2.45 |  1. Determine the value of the coefficient of thermal expansion coefficient at  by using a second order Lagrange polynomial. 2. Fit the previous data to a first degree equation and estimate the coefficient of thermal expansion at the temperature of . |
| Pr.58 | The table below presents enthalpy data for saturated water vapor at various temperatures. Using a direct method of quadratic interpolation, find the corresponding to a temperature of 270 °C. |
| Pr.59 | |  |  | | --- | --- | |  |  |   Write the Newton interpolation polynomial (choose the full third order polynomial) "[ Find the third order Newton divided-difference interpolating polynomial]". If a user runs the engine for 1.55 hours, determine the estimated fuel consumption using. |
| Pr.60 | A tank is filled with water to a certain level *H*0. A valve is opened and the time *T* required for the tank to empty completely is recorded. The following data was obtained.  Find the third order Newton divided-difference interpolating polynomial *f*3(*H*0) suitable for estimating the emptying time when the tank is initially filled with somewhere between 20 and 30 ft of water. |
| Pr.61 | An alternating current *i* has the following values at equal intervals of 2.0 milliseconds  Use Newton Forward Divided Difference’s rule to determine the approximate current in the 7 millisecond period.   |  |  | | --- | --- | | Time (ms) | Current *i* (A) | | 0 | 0 | | 2 | 3.5 | | 4 | 8.2 | | 6 | 10 | | 8 | 7.3 | | 10 | 2 | |
| Pr.62 | An alternating current *i* has the following values at equal intervals of 2.0 milliseconds  Use Newton Backrward Divided Difference’s rule to determine the approximate current in the 7 millisecond period.   |  |  | | --- | --- | | Time (ms) | Current *i* (A) | | 0 | 0 | | 2 | 3.5 | | 4 | 8.2 | | 6 | 10 | | 8 | 7.3 | | 10 | 2 | |
| Pr.63 | The pressure of a gas corresponding to various volumes *V* is measured, given by the following data:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | ***V (cm3)*** | ***50*** | ***56*** | ***60*** | ***63*** | ***65*** | | ***P bar*** | ***6.47*** | ***5.13*** | ***4.05*** | ***3.06*** | ***2.66*** |   Using all (full) data point find the pressure of the gas at a volume of 110 cm3. |
| Pr.64 | Torque-speed data for an electric motor is given in the first two columns of the table below. Using the Forward (Backward) Newton divided-difference interpolation, estimate the torque at 1800 rpm. |
| Pr.65 | Air pressure varies with altitude in the troposphere. The following table contains several data points reflecting the variation of air pressure with the altitude   |  |  | | --- | --- | | Altitude, h (*ft*) | Pressure, P (psi) | | 0 | 14.70 | | 10000 | 10.10 | | 20000 | 06.76 | | 30000 | 04.37 | | 40000 | 03.08 |   Using the Forward (Backward) Newton divided-difference interpolation, estimate the pressure at 38000 *ft*. |
| Pr.66 | Estimate the temperature of T(0.62,0.87) using Lagrange multivariable linear interpolation |
| Pr.67 | **The table shows the variation of the relative thermal conductivity *k* of sodium with temperature *T*. Find the thermal conductivity *k* of sodium at 30 °C by using linear Lagrange method.**   |  |  | | --- | --- | | ***T*** | ***K*** | | 19 | 4.946 | | 25 | 3.932 | | 33 | 3.839 | | 40 | 3.759 | | 50 | 3.393 | |

***Fourier series***

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| Pr.68 | Obtain a Fourier series for the periodic function *f* (*x*) defined as: |
| Pr.69 | Obtain the Fourier series expansion of the periodic function *f* (*t*) of period 2π defined by *f* (*t*) = *t* (0 < *t* < 2π). |
| Pr.70 | A periodic function *f* (*t*) with period 2π is defined by *f* (*t*) = *t*2 + *t , where* (−π < *t* < π). Obtain a Fourier series expansion of the function. |
| Pr.71 | Obtain the Fourier series for the square wave shown in the figure below: |
| Pr.72 | Determine the Fourier series for the periodic function (has a period of 2π) defined by: |
| Pr.73 | Determine the Fourier series for the function  *f (θ)=θ2* in the range −π<θ<π. The function has a period of 2π. |
| Pr.74 | Determine the Fourier series for the function  *f (x)= x+1*  in the range 0<*x*< 2π. |
| Pr.75 | Determine the Fourier series for the following function: |
| Pr.76 | Determine the Fourier series for the function  *f (x)=sin(x)* in the range 0< *x* < π. |
| Pr.77 | The voltage from a square wave generator is of the form:    Find the Fourier series for this periodic function |

***Partial Differential Equation***

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| Pr.78 | A transient heat transfer is occurs in a straight wall through the y-axes only. Find the temperature relation with y & t, T(y,t) {θ(y,t)}. The thermal conductivity is constant through the wall and no heat generation in it (wall) |
| Pr.79 | A transient heat transfer is occurs in a straight wall through the x-axes only. Find the temperature relation with x & t, T(x,t) {θ(x,t)}. The thermal conductivity is constant through the wall and no heat generation in it (wall) |
| Pr.80 | A steady state heat transfer is occurs in a straight wall through the x y-axis. Find the temperature relation with x & y, T(x,y) {θ(x,y)}. The thermal conductivity is constant through the wall and no heat generation in it (wall). |