① Numerical methods in civil engineering are now used routinely in structural analysis to determine the member forces & moments in structural system, Prior to design, They are most useful in analysing civil engineering problems with complicated ~~geometrical~~ geometrical analysis, material property and loading conditions where analytical methods are either very difficult or impossible to use

- Numarical methods provide a way to solve problems quickly and easily compared to analythic solutions.

- Numerical methods can be used in problems of fluid for eg! solving the balance of flow at a junction. for incomprissible fluid flow in pipes.

- The problems of conservation of mass can be easily solved with the help of the numerical methods in various problems of air pollutions or reactors in environmental & water waste engineering.

② Sol^{n}

Since the given number is in base 10, we will convert it to binary, octal and hexa decimal

To binary:

2	456	0
2	228	0
2	114	0
2	57	1
2	28	0
2	14	0
2	7	1
2	3	1
	1	

1.648	0.824 * 2	1
1.296	0.648 * 2	1
0.592	0.292 * 2	0
1.184	0.892 * 2	1
0368	0.184 * 2	0
0.736	0.368 * 2	0

⇒ 456.824 in binary is ~~[illegible]~~ : 111001000 . 110100

To octal: 111001000 . 110100

7 1 0 6 4

⇒ 456.824 to octal will give us 710.64

To Hexa decimal:

	456	
16	28	8
16	1	12
16	0	1

⇒ 1C8

13.184	0.824 * 16	13
2.944	0.184 * 16	2
15.104	0.944 * 16	15
1.664	0.104 * 16	1
10.624	0.664 * 16	10

⇒ 02F1A

456.824 = 1C8.02F1A

(5) (a) $(2C.0B7)_{16}$

$= 2*16^{1} + C*16^{0} . 0*16^{-1} + B \times 16^{-2} + 7*6^{-3}$

$= 32 + 12 . 0.0446773$

$= (44.0446773)_{10}$

(b) $(48.D9)_{16}$

$= 4*16^{1} + 8*16^{0} . D*16^{-1} + 9 \times 16^{-2}$

$= 64 + 8 . 8476562$

$= (72.8476562)_{10}$

(c) $(74E.6A)_{16}$

$= 7*16^{2} + 4*16^{1} + E*16^{0} . 6*16^{-1} + A*16^{-2}$

$= 1792 + 64 + 14 . 4140625$

$= (1870.414062)_{10}$

(9) req: Find % error in area of a rectangle.

soln: % error in length $= \frac{\Delta L}{L} * 100 = \frac{1}{100} * 100 = 1\%$

% error in breadth $= \frac{\Delta b}{b} * 100 = \cancel{1/100} * \cancel{100} = 1\%$

% error in area $= 1\% + 1\% = 2\%$

(11) (a) req: % error in density

sol^n: $\rho = m/v$

$$\frac{d}{dx}\left(\log \rho = \log m - \log v\right)$$

$$\Rightarrow \frac{d\rho}{\rho} = \frac{dm}{m} + \frac{dv}{v}$$

$$= 5/520 + 2/130$$

$$= \frac{5 + 2\times4}{520} = \frac{13}{520}$$

$$= 0.025$$

$$= 0.025 \times 100\%$$

$$= 2.5\%$$

(b) req: density of liquid

sol^n: $\rho = \rho' + \Delta\rho$

$$\Delta\rho = \frac{m'|\Delta v|}{v^2} + \frac{v'|\Delta m|}{v^2}$$

$$\Delta\rho = \frac{520(2)}{16900} + \frac{130(5)}{16900}$$

$$= 0.0615384 + 0.0384615$$

$$= 0.0999999$$

$$\rho' = \frac{m'}{v'} = \frac{520}{130} = 4$$

$$\rho = \rho' + \Delta\rho = 4 + 0.0999999$$

$$= 4.0999999$$

(12) req: % error introduced in Calculation of max bending stress

sol^n:

$\Rightarrow$ max bending stress developed in straight member

$$\sigma_{max} = \frac{Mc}{I} = \frac{50(10)^3(0.1)}{\frac{1}{12}(0.1)(0.2)^3} = 75\,Mpa$$

$\Rightarrow$ stress developed on curved member.

$$R = \frac{A}{\int \frac{dA}{r}} = \frac{0.1(0.2)}{0.1 \ln \frac{0.4}{0.2}} = 0.288539\,m$$

$\Rightarrow$ $e = \bar{r} - R = 0.011461\,m$

M = 50 KN.m, since it tends to decrease the curvature of the curved member

$$\sigma_B = \frac{M(R - r_B)}{Aer_B} = \frac{50(10)^3(0.288539 - 0.4)}{(0.1)(0.2)(0.011461)(0.4)} = 60.78\,Mpa \text{ (Compression)}$$

$$\sigma_A = \frac{M(R - r_A)}{Aer_A} = \frac{50(10)^3(0.288539 - 0.2)}{(0.1)(0.2)(0.011461)(0.2)} = 96.57\,Mpa \text{ (tension)}$$

$$\% \text{ error} = \frac{96.57 - 75}{96.57} = 0.223$$

$\Rightarrow$ $0.223 * 100\% = 22.3\%$

(14) **req**: max error in the measurement of strain

Sol^n: Total error of strain

$$|\delta \varepsilon| = \left|\frac{\partial \varepsilon}{\partial F} \Delta F\right| + \left|\frac{\partial \varepsilon}{\partial A} \Delta A\right| + \left|\frac{\partial \varepsilon}{\partial E} \Delta E\right|$$

$$\frac{\partial \varepsilon}{\partial F} = 1/AE$$

$$\frac{\partial \varepsilon}{\partial A} = -\frac{F}{A^2 E}$$

$$\frac{\partial \varepsilon}{\partial E} = -F/AE^2$$

$$|\delta E| = \left|\left(1/(0.2)(210 * 10^9)\right) * 0.5\right| + \left|\frac{-50}{(0.2)^2 * (210 \times 10^9)} * 0.02\right| + \left|\left(-50/(0.2)(210 \times 10^9)^2\right) 1V1\right|$$

$$= 1.19 \times 10^{-11} + 1.19 \times 10^{-11} + 5.67 * 10^{-12}$$

$$= \underline{\underline{2.95 \times 10^{-11}}}$$

(17) (a) req: Find 3rd taylor polynomial

$F(x) = 2x\cos(2x) - (x-2)^2$

$f'(x) = 2\cos(2x) - 4x\sin(2x) - 2x + 4$

$f''(x) = - 8\sin(2x) - 8x\cos(2x) - 2$

$f'''(x) = (f''(x))' = -24\cos(2x) + 16x\sin(2x)$

$\Rightarrow x_0 = 0$

$f(0) \Rightarrow -4$

$f'(0) \Rightarrow$

$f''(0) \Rightarrow -2$

$f'''(0) \Rightarrow -24$

$$P_3(x) = \frac{f^0(0)}{0!}(x-0)^0 + \frac{f'(0)}{1!}(x-0)^1 + \frac{f^2(0)}{2!}(x-0)^2 + \frac{f^3(0)}{3!}(x-0)^3$$

$P_3(x) = -4 + 6x - x^2 - 4x^3$

$P_3(x)$ at $x = 0.4$

$P_3(0.4) = -4 + 6(0.4) - (0.4)^2 - 4(0.4)^3$

$= -2.016$

(b) req: Find upper bound for error

$$\frac{f^4(c)}{4!}(0.4)^4 \le \frac{76.8}{24}(0.4)^4 = \underline{0.08192}$$

$|f(0.4) - P_3(0.4)| = |-2.002634 + 2.016|$

$= 0.133653$ approximated to $\underline{1.34 \times 10^{-3}}$