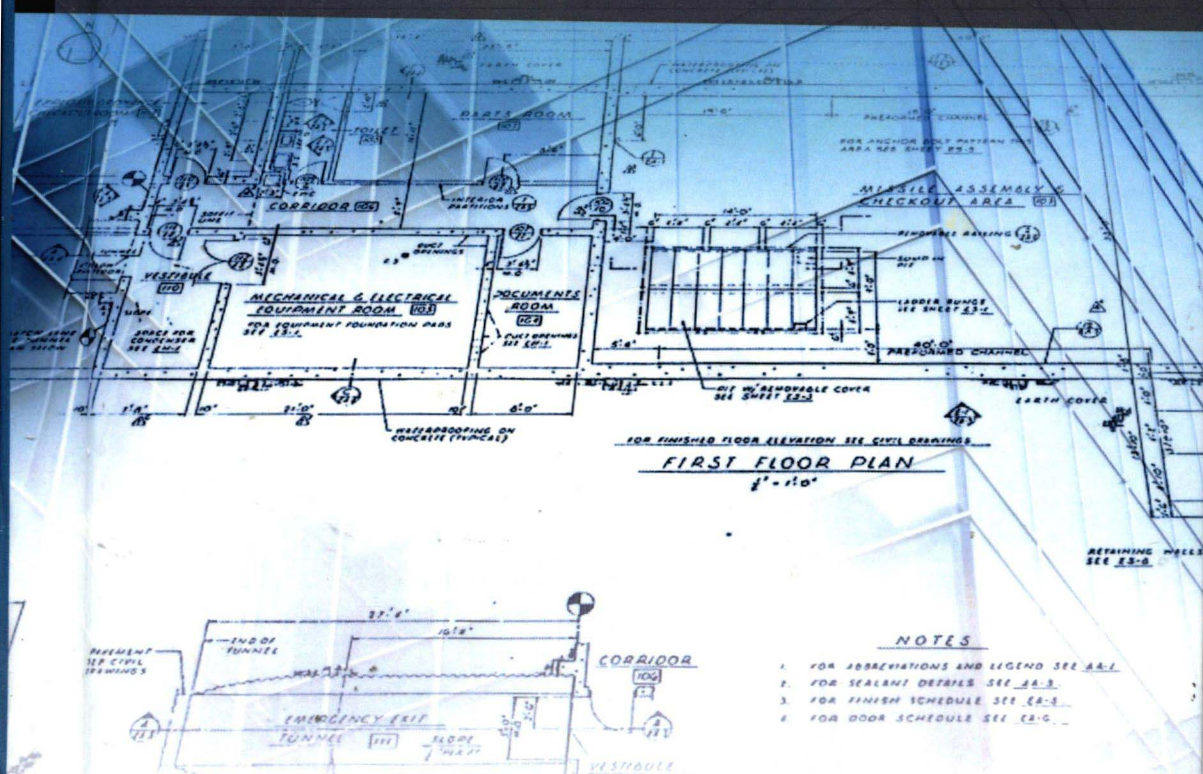
Mathematical Concepts for Mechanical Engineering Design

Kaveh ein Sahleh, PhD | Soltan Ali Ogli Aliyev, PhD



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Kaveh Hariri Asli, PhD, Hossein Sahleh, PhD, and Soltan Ali Ogli Aliyev, PhD

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ABOUT THE AUTHORS

Kaveh Hariri Asli, PhD

Kaveh Hariri Asli, PhD, is a professional mechanical engineer with over 30 years of experience in practicing mechanical engineering design and teaching. He is the author of over 50 articles and reports in the fields of fluid mechanics, hydraulics, automation, and control systems. Dr. Hariri has consulted for a number of major corporations.

Hossein Sahleh, PhD

Hossein Sahleh, PhD, is a university lecturer with 30 years of experience in teaching and research in mathematics. He is the author of many papers in journals and conference proceedings and is an editorial board member of several journals.

Soltan Ali Ogli Aliyev, PhD

Soltan Ali Ogli Aliyev, PhD, is Deputy Director of the Department of Mathematics and Mechanics at the National Academy of Science of Azerbaijan (AMEA) in Baku, Azerbaijan. He served as a professor at several universities. He is the author and editor of several book as well as of a number of papers published in various journals and conference proceedings.

LIST OF ABBREVIATIONS

FD	Finite differences
FE	Finite elements
FV	Finite volume
FVM	Finite volume method
MOC	Method of characteristics
PLC	Program logic control
RTC	Real-time control
WCM	Wave characteristic method

LIST OF SYMBOLS

V = water flow or discharge $\left(m^3/s\right)$, $\left(lit/s\right)$

C = the wave velocity $\left(m/s\right)$

$E_{æ}$ = modulus of elasticity of the liquid (water), $MR = a + bt + ct^2$, $\left(kg/m^2\right)$

E = modulus of elasticity for pipeline material Steel, $D_{EFF} = \alpha_F D_{AV}$

d = outer diameter of the pipe (m)

δ = wall thickness (m)

V_0 = liquid with an average speed $\left(m/s\right)$

T = time (S)

h_0 = ordinate denotes the free surface of the liquid (m)

u = fluid velocity $\left(m/s\right)$

λ = wavelength

$(hu)_x$ = amplitude a

$\frac{\partial h}{\partial t} dx$ = changingthe volume of fluid between planes in a unit time

h_0 = phase velocity $\left(m/s\right)$

v_Φ = expressed in terms of frequency

f = angular frequency

ω = wave number

$\mathbf{\Phi}$ = a function of frequency and wave vector

$v_\Phi(k)$ = phase velocity or the velocity of phase fluctuations $\left(m/s\right)$

$\lambda(k)$ = wavelength

k = waves with a uniform length, but a time-varying amplitude

$k_{**}(\omega)$ = damping vibrations in length

ω = waves with stationary in time but varying in length amplitudes

p_{si0}= saturated vapor pressure of the components of the mixture at an initial temperature of the mixture T_0,(pa)

μ_2, μ_1 = molecular weight of the liquid components of the mixture

B = universal gas constant

p_i = the vapor pressure inside the bubble (pa)

T_{ki} =temperature evaporating the liquid components ($°C$)

l_i = specific heat of vaporization

D = diffusion coefficient volatility of the components

N_{k_0}, N_{c_0} = molar concentration of 1-th component in the liquid and steam

c_l =the specific heats of liquid

a_l = vapor at constant pressure

a_l = thermal diffusivity

ρ_v = vapor density $\left({kg}/{m^3}\right)$

$R = r = R(t)$ = radius of the bubble (m)

λ_l = coefficient of thermal conductivity

ΔT = overheating of the liquid ($°C$)

β = is positive and has a pronounced maximum at k_0 = 0,02

p_1 and p_2 = the pressure component vapor in the bubble (pa)

p_∞ = the pressure of the liquid away from the bubble (pa)

σ = surface tension coefficient of the liquid

ν_1 = kinematic viscosity of the liquid

k_R = the concentration of the first component at the interface

n_i = the number of moles

V = volume (m^3)

B = gas constant

T_v = the temperature of steam (°C)

$\rho_i^{/}$ = the density of the mixture components in the vapor bubble $\left(kg/m^3\right)$

μ_i = molecular weight

p_{si} = saturation pressure (pa)

l_i = specific heat of vaporization

k = the concentration of dissolved gas in liquid

v_Φ = speed of long waves

h = liquid level is above the bottom of the channel

ξ = difference of free surface of the liquid and the liquid level is above the bottom of the channel (a deviation from the level of the liquid free surface)

u = fluid velocity $\left(m/s\right)$

τ = time period

a = distance of the order of the amplitude

k = wave number

$v_\Phi(k)$ = phase velocity or the velocity of phase fluctuations

$\lambda(k)$ = wave length

$\omega_{**}(k)$ = damping the oscillations in time

λ = coefficient of combination

q = flow rate $\left(m^3/s\right)$

μ = fluid dynamic viscosity $\left(kg/m.s\right)$

γ = specific weight $\left(N/m^3\right)$

j = junction point (m)

y = surgetank and reservoir elevation difference (m)

k = volumetriccoefficient $\left(GN/m^2\right)$

T = period of motion

A = pipe cross-sectional area (m^2)

dp = static pressure rise (m)

h_p = head gain from a pump (m)

h_L = combined head loss (m)

E_υ = bulk modulus of elasticity (pa), $\left(kg/m^2\right)$

α = kinetic energy correction factor

P = surge pressure (pa)

g = acceleration of gravity $\left(m/s^2\right)$

K = wave number

T_P = pipe thickness (m)

E_P = pipe module of elasticity, (pa) $\left(kg/m^2\right)$

E_W = module of elasticity of water (pa), $\left(kg/m^2\right)$

C_1 = pipe support coefficient

$Y\max = Max.$ Fluctuation

R_0 = radiuses of a bubble (m)

D = diffusion factor

β = cardinal influence of componential structure of a mixture

N_{k_0}, N_{c_0} = mole concentration of 1-th component in a liquid and steam

γ = Adiabatic curve indicator

c_l, c_{pv} = specific thermal capacities of a liquid at constant pressure

a_l = thermal conductivity factor

ρ_v = steam density $\left(kg/m^3\right)$

R = vial radius (m)

λ_l = heat conductivity factor

k_0 = values of concentration, therefore

w_l = velocity of a liquid on a bubble surface $\left(m/s\right)$

p_1 and p_2 = pressure steam component in a bubble (pa)

p_∞ = pressure of a liquid far from a bubble (pa)

σ and v_1 = factor of a superficial tension of kinematics viscosity of a liquid

B = gas constant

T_v = temperature of a mixture $(°C)$

$\rho_i^/$ = density a component of a mix of steam in a bubble $\left({kg}/{m^3}\right)$

μ_i = molecular weight

j_i = the stream weight

i = components from an $(i = 1,2)$ inter-phase surface in $r = R(t)$

w_i = diffusion speeds of a component on a bubble surface $\left({m}/{s}\right)$

l_i = specific warmth of steam formation

k_R = concentration 1-th components on an interface of phases

T_0, T_{ki} = liquid components boiling temperatures of a binary mixture at initial pressure p_0, $(°C)$

D = diffusion factor

λ_l = heat conductivity factor

Nu_l = parameter of Nusselt

a_l = thermal conductivity of liquids

c_l = factor of a specific thermal capacity

p_{el} = Number of Pekle

Sh = parameter of Shervud

pe_d = diffusion number the Pekle

ρ = density of the binary mix $\left({kg}/{m^3}\right)$

t = time (s)

λ_0 = unitof length

V = velocity $\left(m/s\right)$

S = length (m)

D = diameterof each pipe (m)

R = piperadius (m)

ν = fluiddynamic viscosity $\left(\frac{kg}{m.s}\right)$

h_p = head gain from a pump (m)

h_L = combinedhead loss (m)

C = velocityof surge wave $\left(\frac{m}{s}\right)$

$\frac{P}{\gamma}$ = pressurehead (m)

Z = elevationhead (m)

$\frac{V^2}{2g}$ = velocityhead (m)

γ = specific weight $\left(\frac{N}{m^3}\right)$

Z = elevation (m)

H_P = surgewave head at intersection points of characteristic lines (m)

V_P = surgewave velocity at pipeline points- intersection points of characteristic lines $\left(\frac{m}{s}\right)$

V_{ri} = surgewave velocity at right hand side of intersection points of characteristic lines $\left(\frac{m}{s}\right)$

H_{ri} = surgewave head at right hand side of intersection points of characteristic lines (m)

V_{le} = surgewave velocity at left hand side of intersection points of characteristic lines $\left(\frac{m}{s}\right)$

H_{le} = surgewave head at left hand side of intersection points of characteristic lines (m)

p = pressure (bar), $\left(\frac{N}{m^2}\right)$

dv = incrementalchange in liquid volume with respect to initial volume

$\left(\frac{d\rho}{\rho}\right)$ = incremental change in liquid density with respect to initial density

SUPERSCRIPTS

C^{-} = characteristic lines with negative slope

C^{+} = characteristic lines with positive slope

SUBSCRIPTS

$Min.$ = Minimum

$Max.$ = Maximum

$Lab.$ = Laboratory

MOC = Method of Characteristic

PLC = Program Logic Control