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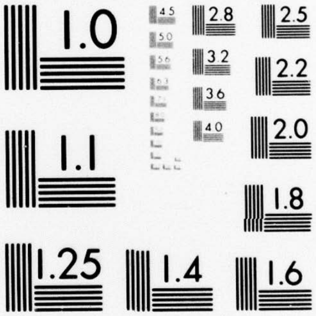

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AIR FORCE SYSTEMS COMMAND

UNSTEADY FLOW OF A VISCOUS FLUID

By

A. N. Gots, G. K. Berman and K. V. Valikov

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distribution unlimited.

EDITED TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh^{-1}
cos	cos	ch	cosh	arc ch	cosh^{-1}
tg	tan	th	tanh	arc th	tanh^{-1}
ctg	cot	cth	coth	arc cth	coth^{-1}
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

1110

UNSTEADY FLOW OF A VISCOUS FLUID

A. N. Gots, G. K. Berman and K. V. Valikov

We will consider the unsteady flow of a viscous fluid in a rectangular channel. We will direct the z-axis along the channel, whose width will be designated as a, and height - b. We will consider the flow conditions to be isothermic and unsteady. In this case, the differential equation of motion [1] is

$$\frac{\partial v}{\partial t}=\frac{f(t,z)}{\rho}+\nu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right). \qquad (1)$$

where v is the flow rate on the z-axis; ρ is the density of the fluid; $f(t, z)=-\frac{\partial P}{\partial z}$ is the pressure gradient; $\nu=\frac{\eta}{\rho}$ is the kinematic viscosity coefficient; and η is the viscosity of the fluid.

Equation (1) was written with the assumption that $v_x = v_y = 0$; v_z = v(x, y, z). The initial and boundary conditions are

$$v|_{t=0} = 0; \; v|_{\Gamma} = 0, \tag{2}$$

where Γ is the cross-sectional profile.

We will search for the solution to differential equation (1) with conditions (2) in the form [2]

$$v(x, y, t) = \sum_{n,m=0}^{\infty} v_{nm}(t) \sin\frac{\pi(2n+1)x}{a} \sin\frac{\pi(2m+1)y}{b}, \tag{3}$$

where v_{nm} is the coefficient to be determined.

We will expand function f(t, z) into a binary Fourier series, after the calculation of the coefficients of which we will have

$$f(t, z) = \frac{16}{\pi^2} \sum_{n,m=0}^{\infty} \frac{1}{(2n+1)(2m+1)} \sin\frac{\pi(2n+1)x}{a} \sin\frac{\pi(2m+1)y}{b}. \tag{4}$$

Substituting expressions (3) and (4) in equation (1), and also considering conditions (2), we will find

$$v_{nm}(t) = \frac{16}{\pi^2 \rho (2n+1)(2m+1)} \int_0^t e^{-\nu\left[\frac{(2n+1)^2}{a^2} + \frac{(2m+1)^2}{b^2}\right](t-\tau)} f(z, \tau)\, d\tau. \tag{5}$$

Thus, solutions (3) and (5) obtained make it possible to find the law of the distribution of the velocity of a viscous fluid in a rectangular channel.

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2. N. S. Koshlyakov, E. B. Gliner, M. M. Smirnov. Main Differential Equations of Mathematical Physics, Fizmatgiz, M., 1962.

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