SHIMANOV, S N.

SUBJECT USSR/MATHEMATICS/Differential equations CARD 1/3 PG - 501
AUTHOR SIMANOV S.N.
TITLE On the determination of the characteristic exponents of a linear system of differential equations with periodic coefficients.
PERIODICAL Doklady Akad.Nauk 109, 1102-1105 (1956)
reviewed 1/1957

Let be given the system

(1) $$\frac{dx}{dt} = (A + \mu F(t, \mu))x.$$

Here $x = (x_1,\ldots,x_n)$; $A = \|a_{ji}\|$ $(j,i=1,\ldots,n)$, a_{ji} constants; $F(t,\mu) = \|f_{ji}\|$ $(j,i=1,\ldots,n)$, f_{ji} continuous functions being 2π-periodic in t, which are analytic in μ for $0 < |\mu| < \mu^*$. Let the equation

(2) $$|A - E\lambda| = 0$$

have $k \leq n$ roots which are eitner equal λ_1 or differ from λ_1 by $\pm N\sqrt{-1}$, N integral. Let the system

(3) $$\frac{dx}{dt} = (A - E\lambda_1)x$$

admit $m \leq k$ solution groups

$$x_1^{(i)} = \varphi_1 , \quad x_2^{(i)} = \varphi_i t + \varphi_i^{(2)}, \ldots .$$

$$\ldots , x_{\nu_i}^{(i)} = \varphi_i \frac{t^{\nu_i - 1}}{(\nu_i - 1)!} + \ldots + \varphi_i^{(\nu_i - 1)} t + \varphi_i^{(\nu_i)} \qquad (\varphi_i^{\nu_i} = \varphi_i^*),$$

where φ are periodic vectors with period 2π and ν_i are integers which satisfy the condition $\nu_1 + \nu_2 + \ldots + \nu_m = k$. Let ψ_j $(j=1,\ldots,m)$ be linearly independent periodic solutions of the system conjugated to (3). Then

$$(\varphi_i^{(\sigma)} \cdot \psi_j) = 0 \qquad (\sigma = 1,\ldots,\nu_i - 1; \quad i,j = 1,2,\ldots,m)$$

and

$$(\varphi_i^* \cdot \psi_j) = \delta_{ij} .$$

The characteristic exponent, which for $\mu = 0$ changes to the root λ_1, be $\lambda_1 + \alpha(\mu)$ $(\alpha(0) = 0)$. Putting

$$b_{ij} = \frac{1}{2\pi}\int_0^{2\pi} \sum_{s,\sigma=1}^{n} f_{s\sigma}(t,0)\,\psi_{\sigma j}\,\varphi_{si}\,dt$$

$B = |b_{ij}|$, $\vec{\alpha} = \{\alpha^{\nu_1},\ldots,\alpha^{\nu_m}\}$, $\varphi_s = \{\varphi_{s1},\ldots,\varphi_{sn}\}$,
then the theorem holds: If $B \neq 0$, then the analytic form of the function $\alpha(\mu)$ and the first terms of its series development in terms of integral or broken powers of μ agree with the roots of the equation

$$|\mu B - E\vec{\alpha}| = 0.$$

From the proof of the theorem the author obtains a further assertion: If $\nu_1 = \nu_2 = \ldots = \nu_m = 1$, then to a simple root α_1 of the equation $|B - E\vec{\alpha}| = 0$ there corresponds a characteristic exponent $\lambda = \lambda_1 + \mu\alpha_1 + \mu^2(\ldots)$, being analytic with respect to μ.

INSTITUTION: Public University, Ural.

Shimanov, S.N.

AUTHOR: Shimanov, S.N. (Sverdlovsk) 40-21-2-12/22

TITLE: Oscillations of Quasi-Linear Systems With a Non-Analytic Characteristic of the Non-Linearity (Kolebaniya kvazilineynykh sistem s neanaliticheskoy kharakteristikoy nelineynosti)

PERIODICAL: Prikladnaya Matematika i Mekhanika, 1957, Vol 21, Nr 2, pp 244-252 (USSR)

ABSTRACT: The author considers the system

$$(1)\ \frac{dx_s}{dt} = a_{s1}x_1 + \dots + a_{sn}x_n + \mu F_s(t, x_1, \dots, x_n, \mu)\ (s=1,\dots,n),$$

where a_{si} are constants, F_s are continuous and periodic functions in t (period 2π) and continuous functions of x, $x \in G$ and μ, $\mu < \mu^*$. The F_s satisfy the conditions of Cauchy-Lipschitz with respect to x.
In earlier papers, Malkin [Ref 2] and the author [Ref 4] have determined the periodic solutions of (1) for the case of resonance if the conditions for the existence of a unique periodic solution were satisfied. In the present paper a

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method for the determination of the periodic solution of (1) is proposed being independent of this condition. The author establishes necessary and sufficient conditions that (1) has a periodic solution which for ' = 0 goes over to one of the periodic solutions of the generating system. The knowledge of the general solution of (1) in the neighborhood of the periodic solution of the generating system is not necessary; in place of that a periodic solution of an auxiliary system of integro-differential equations depending on several parameters has to be determined. For the solution of the auxiliary system an approximate method is given. In some cases the obtained approximations are sufficient to prove the existence of the periodic solution of (1), and with the aid of these approximations one may obtain an approximation for these periodic solutions of (1). There are 4 references, 3 of which are Soviet, and 1 American.

SUBMITTED: January 5, 1955

AVAILABLE: Library of Congress

Card 2/2 1. Cauchy functions—Applications 2. Lipschitz functions—Applications

SOV/140-58-4-29/30

AUTHOR: Shimanov, S.N.

TITLE: On Almost-Periodic Solutions of Inhomogeneous Linear Differential Equations With Retardation (O pochti-periodicheskikh resheniyakh neodnorodnykh lineynykh differentsial'nykh uravneniy s zapazdyvaniyem)

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Matematika, 1958, Nr 4, pp 270-274 (USSR)

ABSTRACT: The author considers the system

$$\frac{dx(t+\tau)}{dt} = ax(t+\tau) + bx(t) + f(t),$$

where x is a vector, a and b are constant matrices, $f(t) = \{f_1(t), f_2(t), \ldots f_n(t)\}$ is a vector with almost periodic components to which there correspond the Fourier expansions $f_j(t) = \sum d_{j\nu} e^{\nu i t}$.
Theorem: If the roots λ_k of the equation $\Delta(\lambda) \equiv |ae^{\tau\lambda} \cdot E^{\tau\lambda} + b| = 0$ satisfy the condition $\mathrm{Re}\,\lambda_k < -2\alpha < 0$ ($\alpha = \mathrm{const} > 0$) and if $f_j(t)$, $f'_j(t)$ are almost periodic, then it holds: 1) (1) has one and only one almost periodic solution

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$$x^*_\sigma(t) \sim \sum_\nu \sum_{k=1}^{n} \frac{\Delta_{\sigma k}(\nu i)}{\Delta(\nu i)} d_{k\nu} e^{\nu i t} \qquad (\sigma = 1, \ldots, n),$$

where $\Delta_{\sigma k}$ are the algebraic complements of Δ. 2) $|x^*_\sigma(t)| < AM$, where M is the upper boundary of f_j and f_j' on $(-\infty, \infty)$ and A = const. depending only on a, b, τ and not depending on $f_j(t)$.
There are 3 references, 1 of which is Soviet, 1 Danish, and 1 Italian.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A.M.Gor'kogo (Ural State University imeni A.M.Gor'kiy)

SUBMITTED: January 31, 1958

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001549510007-9"

AUTHOR: Shimanov, S.N. (Sverdlovsk) SOV/40-22-3-11/21

TITLE: On the Determination of the Characteristic Exponents of Systems of Linear Differential Equations With Periodic Coefficients (Ob otyskanii kharakteristicheskikh pokazateley sistem lineynykh differentsial'nykh uravneniy s periodicheskimi koeffitsiyentami)

PERIODICAL: Prikladnaya matematika i mekhanika, 1958, Vol 22, Nr 3, pp 382 - 385 (USSR)

ABSTRACT: The author investigates a system of linear differential equations of the following form :

$$(1) \quad \frac{dx_s}{dt} = \sum_{i=1}^{n} (a_{si} + \mu f_{si}(t,\mu)) x_i \qquad (s = 1,\ldots,n)$$

here the a_{si} are constants, the f_{si} are continuous and periodic functions with respect to the time and analytic functions with respect to the parameter μ. Two theorems are derived and proved which are important for the determination of the characteristic exponents for the solutions of the given system.

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On the Determination of the Characteristic Exponents of Systems of Linear Differential Equations With Periodic Coefficients SOV/40-22-3-11/21

Theorem 1 : To the simple root $\alpha = \alpha^*$ of the equation

$$\Delta(\alpha) = \left| b_{ij} - \delta_{ij}\alpha \right| = 0$$

$$b_{ij} = \frac{1}{\omega} \int^{\omega} \sum \sum f_{s\sigma} \left[(t,0) \varphi_{\sigma j} \psi_{si} \, dt\right]$$

corresponds a characteristic exponent of the form :

$$\lambda = \lambda_1 + \mu\alpha^* + \mu^2\alpha_2 + \dots$$

which is analytic with respect to the parameter μ.

Theorem 2 : With

$$P_i^{(\sigma)}(c_1 \dots c_m) = \left[\frac{d^{\sigma-1}}{d\mu^{\sigma-1}} \left[W_i \, (c_1 \dots c_m, \mu, 0) \right] \right]_{\mu=0} \equiv 0$$

there holds the following theorem: If $\alpha = \alpha^*$ is a simple root of the equation

$$\left| \frac{\partial P_i^{(k)}}{\partial c_j} - \delta_{ij}(\alpha) \right| = 0$$

Card 2/3 then the characteristic exponent corresponding to this root is an analytic function of the parameter μ of the form

$$\lambda = \lambda_1 + \mu^k \alpha^* + \mu^{k+1} \alpha_{k+1} + \dots \quad .$$

If a multiple root exists, then the characteristic exponent has the form

$$\lambda = \lambda_1 + \mu \alpha^* + \mu^{1+1/r} \alpha_2 + \dots . \quad .$$

There are 3 references, 2 of which are Soviet, and 1 is English.

SUBMITTED: February 2, 1956

16(1) SOV/20-125-6-7/61

AUTHOR: Shimanov, S.N.

TITLE: On Almost Periodic Oscillations in Non-Linear Systems With Retardation (O pochti periodicheskikh kolebaniyakh v nelineynykh sistemakh s zapazdyvaniyem)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 125, Nr 6, pp 1203 - 1206 (USSR)

ABSTRACT: Let the system

(1) $$\frac{dx(t)}{dt} = \sum_{j=1}^{k} a_j x(t - \tau_j) + \varepsilon F(t, x(t-\tau_1), \ldots, x(t-\tau_k), \varepsilon)$$

be given, where $x(t)$ is an n-dimensional vector, a_j a constant quadratic matrix. All the roots of

(2) $$\left| \sum_{j=1}^{k} a_j e^{-\lambda \tau_j} - E\lambda \right| = 0$$

are assumed to satisfy the condition $\mathrm{Re}\,\lambda_i < -2\alpha < 0$. F are almost periodic functions of t and satisfy the Lipschitz

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condition in x ; $|x_i| \leq R$.

Theorem : There exists an $\varepsilon^*(R)$ so that (1) possesses a unique almost periodic solution for every $|\varepsilon| < \varepsilon^*(R)$.

The theorem generalizes a result of G.I. Biryuk. A somewhat more complicated statement of I.G. Malkin is generalized in a similar way.

The author mentions N.N. Bogolyubov.

There are 4 Soviet references.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A.M. Gor'kogo (Ural State University imeni A.M. Gor'kiy)

PRESENTED: January 15, 1959, by N.N. Bogolyubov, Academician

SUBMITTED: January 8, 1959

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16.9500

S/141/60/003/03/010/014
E193/E382

AUTHOR: Shimanov, S.N.

TITLE: Oscillations of Quasilinear Autonomous Delay Systems

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1960, Vol. 3, No. 3, pp. 456 - 466

TEXT: The equation of motion of the autonomous system considered is in the form:

$$\frac{dx(t)}{dt} = \sum_{\sigma=1}^{r} a_{\sigma} x(t - \tau_{\sigma}) + \mu X[x(t - \tau_1), \ldots, x(t - \tau_r), \mu] \quad (1.1)$$

where $x(t) = x_1(t), \ldots, x_n(t)$,

a_{σ} are the matrix constants and

$X = X_1, \ldots, X_n)$.

The functions $X_1, \ldots, X_n$ are differentiable with respect to all the (rn + 1) variables. The quantities τ_1, τ_2 and τ_r are

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constants characterising the delay in the system. It is assumed that the characteristic equation is in the form:

$$\left| \sum_{\sigma=1}^{r} a_\sigma e^{-\tau_\sigma \lambda} - E\lambda \right| = 0 \qquad (1.2)$$

and this has roots in the form $\lambda = N_j \omega \sqrt{-1}$, where N_j are integers and ω is a certain number. It is assumed that all the roots are simple and that at least one of $N_j \neq 0$. The number of roots is m and the solutions corresponding to these roots are given by the generating system defined by Eq.(1.3). The solution corresponding to the zero root is in the form of Eq. (1.4), where A_s are constants. On the other hand, the solutions defined by Eqs (1.5) correspond to the roots $N_j \omega \sqrt{-1}$ and $-N_j \omega \sqrt{-1}$. B_j and D_j in Eqs. (1.5) are constants. The generating solution having a

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period $2\pi/\omega$ is in the form of Eq (1.6), where $M_1, \ldots, M_m$ are arbitrary constants. The independent variable is now changed in accordance with Eq. (1.8). It is now necessary to find the periodic solutions of the system defined by Eq. (1.9). This becomes identical with the periodic generating solutions when $\mu = 0$. In order to obtain the necessary and sufficient conditions for the existence of periodic solutions, which take the form of the generating solution for $\mu = 0$, it is necessary to generalize the method of auxiliary systems (Refs.5,6) to include the system represented by Eq. (1.1). The advantage of this system lies in the fact that in order to determine the necessary and sufficient conditions for the existence of a periodic solution of Eq. (1.1), it is sufficient to find a periodic solution of a certain auxiliary system of integral-differential equations which correspond to the system given by Eq (1.1). Consequently, the system defined by Eq. (2.1) is considered, where f(t) is a periodic vector function having a period $2\pi/\omega$, φ_j are periodic solutions of the homogeneous system defined by Eqs. (1.3), (1.4) and (1.5), while W_j are

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certain constants, which satisfy Eq. (2.2). The solution of Eq. (2.1) can be represented in the form of Eq (2.3), where M_j are arbitrary constants and L_s are certain definite operators which depend on the form of the homogeneous system represented by Eq (1.3). Now the auxiliary system is represented by Eqs. (2.5). The basic properties of this system are stated in two lemmas. The periodic solution of Eqs. (2.5) is in the form of Eq. (2.6). It is then shown that the system defined by Eq. (1.1) has a periodic solution $x_s(t, \mu)$, having a period $T = 2\pi/\omega[1 + \mu\alpha(\mu)]$, which becomes identical with the generating equation defined by Eq.(3.1), when $\mu = 0$. The necessary and sufficient conditions for the existence of a periodic solution of the system represented by Eq. (1.1) is stated in three theorems. It is also shown that if the equations are analytic, the finding of the periodic solutions of the system is easier.

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Oscillations of Quasilinear Autonomous Delay Systems

There are 7 references: 1 French and 6 Soviet.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet (Ural State University)

SUBMITTED: January 28, 1960

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85649

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B019/B063

16.9500 (1024, 1132, 1344)

AUTHOR: Shimanov, S. N. (Sverdlovsk)

TITLE: Oscillation Theory of Quasi-linear Systems With a Constant Delay

PERIODICAL: Avtomatika i telemekhanika, 1960, Vol. 21, No. 6, pp. 706-709

TEXT: The present paper gives the results of a study of almost periodic conditions in quasi-linear systems whose motion is described by ordinary differential equations. The author studies systems whose motion is described by the totality of all differential equations of the form $dx_s(t)/dt = a_{s1}x_1(t) + \ldots + a_{sn}x_n(t) + b_{s1}x_1(t-\tau) + \ldots + b_{sn}x_n(t-\tau) + f_s(t) + \mu F_s\left[t; x_1(t), \ldots, x_n(t); x_1(t-\tau), \ldots, x_n(t-\tau); \mu\right]$ ($s = 1, 2, \ldots, n$) (1). It is shown that (1) yields definite almost periodic solutions $x_s^*(t,\mu)$ for a sufficiently small $|\mu|$ if the characteristic equation $\Delta(\lambda) \equiv \left| a_{si} - \delta_{si}\lambda + b_{si}\exp(-\lambda\tau)\right| = 0$ (2) of (1) has no roots

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Oscillation Theory of Quasi-linear Systems With a Constant Delay

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lying on the imaginary axis λ. It is further shown that the solution $x_s^*(t,\tau)$ of (1) becomes asymptotically stable for $t \longrightarrow +\infty$ if all roots of (2) have negative real values. Finally, it is shown that equation (1) has almost periodic solutions within a sufficiently small range of $|\mu|$, which become stable for $t \longrightarrow +\infty$. In first approximation, these solutions read $x_s = \overline{M}_1\varphi_{s1} + \dots + \overline{M}_m\varphi_{sm} + \varphi_s(t)$ $(s = 1, 2, \dots, n)$, where M_i are the parameters and φ_{sk} solutions of the system $dx_s(t)/dt = a_{s1}x_1(t) + \dots + a_{sn}x_n(t) + b_{s1}x_1(t-\tau) + \dots + b_{sn}x_n(t-\tau) + f_s(t)$ $(s = 1, \dots, n)$ (3). B. V. Bulgakov, A. M. Letov, A. I. Lur'ye, M. A. Ayzerman, Ya. Z. Tsypkin, N. N. Bogolyubov, I. G. Malkin, A. M. Lyapunov, N. G. Chetayev, and N. N. Krasovskiy are mentioned. There are 8 Soviet references.

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16.3400, 16.7000

77981
SOV/40-24-1-9/28

AUTHOR: Shimanov, S. N. (Sverdlovsk)

TITLE: Instability of Motion of Systems With Time Lag

PERIODICAL: Prikladnaya matematika i mekhanika, 1960, Vol 24, Nr 1, pp 55-63 (USSR)

ABSTRACT: Certain stability theorems of Lyapunov (General Problem of Stability of Motion, 1950, Moscow) and Chetayev (Stability of Motion, 1956) are shown to carry over into systems of linear differential equations with time lag:

$$\frac{dx_i(t)}{dt} = X_i(x_1(t+\vartheta),\ldots,x_n(t+\vartheta),t) \quad (i=1,\ldots,n) \qquad (1.1)$$

where $X_i(x_1(\vartheta),\ldots,x_n(\vartheta), t)$ are functionals defined on arbitrary piecewise continuous functions $x_i(\vartheta)$ for $-\tau \leqslant \vartheta \leqslant 0$, and such that $X_i(0,\ldots,0,t) = 0$. The author establishes these as well as instability

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criteria in terms of the first (linear) approximation, by representing a solution as a trajectory in the functional space C. He sets

$$x(t+\vartheta) = (x_{it}(\vartheta))$$

$x_{it}(\vartheta)$ for fixed t being a point in the functional space C (a function defined on the interval $-\tau \leqslant \vartheta \leqslant 0$). The author shows that the equilibrium motion $x_t(\vartheta) = 0$ is unstable if the perturbation differential equations are such that it is possible to find a functional $v[x(\vartheta, t)]$ (defined on the functions $x_1(\vartheta), \ldots, x_n(\vartheta)$ $(-\tau \leqslant \vartheta \leqslant 0)$ in the region $\| x(\vartheta) \| < H$, $t \geqslant t_0$), which is bounded and has an infinitesimal upper bound in the region $v > 0$ of function $x(\vartheta)$ such that (A),

$$\|x(\vartheta)\| \leqslant H, \qquad v(x(\vartheta), t) > 0, \qquad t \geqslant t_0 \qquad (1.6)$$

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the region existing for any $t \geqslant t_0$ and containing differentiable functions $x(\vartheta)$ with arbitrarily small norm, and such th. . the lower derived functional $v_1 [x(\vartheta + t), t]$ of v is positive-definite in the region $v > 0$ of (A). A functional is called positive-definite if a continuous function $w(r)$ can be found satisfying the conditions:

$$v(x_1(\vartheta), \ldots, x_n(\vartheta), t) \geqslant w(\|x(\vartheta)\|) \qquad (1.4)$$
$$w(r)\, r > 0, \qquad 0 < r \leqslant H, \qquad w(0) = 0$$

A functional $v [x(\vartheta), t]$ has an infinitesimal upper bound if one can find a continuous function $w_1(r)$ satisfying the conditions:

$$|v(x_1(\vartheta), \ldots, x_n(\vartheta), t)| \leqslant w_1(\|x(\vartheta)\|) \qquad (1.5)$$
$$w_1(r)\, r > 0, \qquad 0 < r \leqslant H, \qquad w_1(0) = 0$$

The functional $v_1 [x(\vartheta), t]$ is called a lower derived functional of $v [x(\vartheta), t]$, if, upon substituting in this functional any solution $x_t(\vartheta)$ defined by (A):

$$\lim \inf \left(\frac{\Delta v}{\Delta t}\right)_{(1.1)} = v_1 (x_t(\vartheta), t) \quad \textit{for} \quad \Delta t \to +0 \qquad (1.8)$$

the subscript (1.1) denotes the system along a trajectory from which the limit is calculated. From this result follows the generalization of Lyapunov's first instability theorem: The motion $x = 0$ is unstable if one can find a functional $v [x(\vartheta), t]$, such that by suitably imposed initial conditions $x_0(\vartheta)$ sufficiently small (in norm), the functional $v [x_0(\vartheta), t]$ can be made to have the same sign as v_1. Also implied is the generalization of Chetayev's second

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theorem on instability: The motion x = 0 is unstable if v_1 has the form:

$$v_1(x(\vartheta), t) = \lambda v(x(\vartheta), t) + w(x(\vartheta), t)$$

where λ is a positive constant and w is a certain positive functional. The author also considers the single equation

$$\frac{dx(t)}{dt} = \int_{-\tau}^{0} x(t+\vartheta)\, d\eta(\vartheta) + X(x(t+\vartheta), t) \qquad (2.1)$$

where the integral is a Stieltje's integral and the functional X is assumed to satisfy a Lipschutz condition in $x(t+\vartheta)$ and to be continuous in t. The first approximation with lag is shown to be:

$$\frac{dx(t)}{dt} = a_1 x(t) + a_2 x(t-\tau) \qquad (2.2)$$

The author then uses functionals and Lyapunov's theorem to show that the trivial solution of (B) is unstable independently of the form of X if the characteristic equation

$$\Delta(\lambda) = -\lambda + \int_{-\tau}^{0} e^{\lambda\theta} d\eta(\theta) = 0 \qquad (2.5)$$

has at least one root with a positive real part. He notes that the result goes through for the case of multiple roots with positive real parts and for systems of equations with lag. There are 5 Soviet references.

SUBMITTED: November 18, 1959

Shimanov, S. N.

82120

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16.3400

AUTHOR: Shimanov, S. N.

TITLE: On the Stability in the Critical Case of a Zero Root for Systems With Delay

PERIODICAL: Prikladnaya matematika i mekhanika, 1960, Vol. 24, No. 3, pp. 447-457

TEXT: The system

$$(1.1) \qquad \frac{dx_i(t)}{dt} = \sum_{j=1}^{n} \int_{-\tau}^{0} x_j(t+\vartheta)\, d\eta_{ij}(\vartheta) + X_i(x_1(t+\vartheta), \ldots, x_n(t+\vartheta)),\quad i = 1,2,\ldots,n,$$

is considered, where X_i are non-linear disturbances and $-\tau \leq \vartheta \leq 0$. The author assumes that the characteristic equation of the system of the first approximation

$$(1.5) \qquad \frac{dx_i(t)}{dt} = \sum_{j=1}^{n} \int_{-\tau}^{0} x_j(t+\vartheta)\, d\eta_{ij}(\vartheta)$$

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possesses denumerably many roots $\lambda_1, \lambda_2, \ldots$, where $\lambda_1 = 0$ and $\operatorname{Re} \lambda_j \leq -2\alpha \ (j > 1)$.

In order to determine $\frac{dx_i(t)}{dt}$ at the given moment, the course of $x_i(t)$ on the preceding interval $(t - \tau, t)$ must be known. For this reason the author does not consider the point $x_i(t)$ as element of the trajectory but the piece $x_i(t + \vartheta)$, $-\tau \leq \vartheta \leq 0$. According to N. N. Krasovskiy (Ref. 1) then to the system (1.1) there corresponds an equivalent ordinary system

$$(1.8) \qquad \frac{dx_t(\vartheta)}{dt} = Ax_t(\vartheta) + X(x_t(\vartheta))$$

which is considered in a certain function space.

With the aid of a transformation due to A. M. Lyapunov (Ref. 3) (1.8) is brought to the form

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$$(4.1) \qquad \frac{dy}{dt} = Y_1(y, z_{1t}(\vartheta)), \qquad \frac{dz_{1t}(\vartheta)}{dt} = Az_{1t}(\vartheta) + Z_1(y, z_{1t}(\vartheta), \vartheta).$$

Now Y_1 and Z_1 are expanded into the power series $gy^{m} + \ldots$ and $g_1 y^{m_1} + \ldots$ at a certain point. The author states that whether the solution $x = 0$ of (1.1) be asymptotically stable or unstable depends on the fact whether m and m_1 are even or odd and whether g, g_1 are positive or negative. He gives an example.

N. G. Chetayev, J. G. Malkin and G. V Kamenkov are mentioned.

There are 10 references: 8 Soviet, 1 American and 1 Hungarian.

SUBMITTED: December 21, 1959

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81713

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C 111/C 333

AUTHOR: Shimanov, S. N.

TITLE: Almost Periodic Oscillations of Quasilinear Systems With Time Lag in the Case of Degeneration

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 133, No. 1, pp. 36-39

TEXT: The author considers the system

$$(1) \qquad \frac{dx(t)}{dt} = \int_{-\tau}^{0} x(t+\vartheta)\, d\eta(\vartheta) + \varepsilon F(t, x(t+\vartheta), \varepsilon),$$

where $x(t)$ is an n-dimensional vector, $d\eta(\vartheta)$ an n-dimensional matrix; $\| d\eta_{ij}(\vartheta) \|$ a Stieltjes measure, $\eta_{ij}(\vartheta)$ functions of bounded variation. Let the characteristic equation

$$(2) \qquad \Delta(\lambda) \equiv \left| + E_\lambda + \int_{0}^{-\tau} e^{\lambda\vartheta}\, d\eta(\vartheta) \right| = 0$$

possess m critical roots $\lambda_1, \ldots, \lambda_m$, while the real parts of the other roots are smaller than -2α ($\alpha > 0$). The functionals $F(t), x(t+\vartheta), \varepsilon) = \{F_i\}$ are defined in $D(H)$: $\| x(\vartheta) \| \leqq H$ on the piecewise continuous functions $x(\vartheta)$ ($-\tau \leqq \vartheta \leqq 0$) and it is:

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Almost Periodic Oscillations of Quasilinear Systems With Time Lag in the Case of Degeneration

1.) $F(t, x(\vartheta), \varepsilon) = \sum_{k=0}^{\infty} \varepsilon^k F_k(t, x(\vartheta))$ in D_ε : $|\varepsilon| \leq \varepsilon_0$ $(\varepsilon_0 > 0)$
2.) $F(t, x(\vartheta))$ are finite trigonometric sums, if one substitutes in them a piecewise continuous function $x_t(\vartheta) \in D(H)$ in ϑ which for its part is a finite trigonometric sum with respect to t, the frequencies of which do not depend on ϑ, 3.) $F(t, x(\vartheta), \varepsilon)$ satisfy the Lipschitz conditions with respect to the variables x in $D(H)$, D_ε.

To every critical root λ_i there corresponds a periodic solution $\varphi_i(t)$ of (1) with $\varepsilon = 0$. Then the system conjugate to (1) possesses m periodic solutions $\psi_j(t)$ which correspond to the m critical roots λ_j.

Theorem 1: Let $x^o(t) = M_1 \varphi_1(t) + \dots + M_m \varphi_m(t)$ be an almost periodic solution of (1) for $\varepsilon = 0$. If the parameter $M_i = M_i^o$ satisfy the equations

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(5) $$P_i(M_1, \dots, M_m) = \lim \frac{1}{t} \int_0^t \sum_{j=1}^n F_j(t, x_1^o(t+\vartheta), \dots, x_n^o(t+\vartheta)) \cdot \psi_i(t)dt$$

and if the equation

(6) $$\left| \left(\frac{\partial P_i(M)}{\partial M_j} \right)_{M = M^o} - d_{ij}\lambda \right| = 0$$

possesses no roots with vanishing real parts, then for sufficiently small ε (1) admits an almost periodic solution $x^*(t, \varepsilon)$ which for $\varepsilon = 0$ transforms into the generating solution $x^o(t, M^o)$.

The d_{ij} occurring in the theorem are defined by the scalar product

$$d_{ij} = (\varphi_i(t+\vartheta)\psi_j(t+\vartheta)).$$

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Almost Periodic Oscillations of Quasilinear Systems With Time Lag in the Case of Degeneration

Theorem 2 states that, if all noncritical roots of (2) and all roots of (6) possess negative real parts, then the almost periodic solution $x^*(t, \varepsilon)$ of theorem 1 is asymptotically stable for sufficiently small ε. If only one of the above roots has a positive real part, then $x^*(t, \varepsilon)$ is unstable.

The author mentions N. N. Bogolyubov, J. G. Malkin, G. J. Biryuk and N. M. Krylov.

There are 7 Soviet references.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A. M. Gor'kogo (Ural State University imeni A. M. Gor'kiy)

PRESENTED: March 9, 1960, by N. N. Bogolyubov, Academician

SUBMITTED: March 8, 1960

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SHIMANOV, S. N., YELAGOLTS, L. YE. and MYSHKIS, A. D.

"Stability and oscillations of systems with time lag."

Paper presented at the Intl. Symposium on Nonlinear Vibrations, Kiev, USSR, 9-19 Sep 61

Research Technical Physics Low Temperature Institute of the Ukrainian SSR, Academy of Sciences, Kharkov

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C111/C222

16.3400

AUTHOR: Shimanov, S.N.

TITLE: On the stability in the critical case of a zero root for systems with an after-effect (singular case)

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Matematika, no. 1, 1961, 152-162

TEXT: The present paper is a continuation of an earlier paper of the author (Ref. 1 : Ob ustoychivosti v kriticheskom sluchaye odnogo nulevogo kornya dlya sistem s posledeystviyem [On the stability in the critical case of a zero root for systems with an after-effect] PMM v. 24, no. 3, 447-457, 1960) and investigates the singular case.
The author considers the system

$$\frac{dx_i(t)}{dt} = \sum_{j=1}^{n} \int_{-\tau}^{0} x_j(t+\vartheta)\,d\eta_{ij}(\vartheta) + X_i(x_i(t+\vartheta)) \quad (i=1,..,n) \qquad (1.1)$$

where the integrals are understood in the sense of Stieltjes, and the functionals X_i defined on the piecewise continuous functions $x_i(\vartheta)$,
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$-\tau \leq \vartheta \leq 0$, satisfy the conditions

$$|X_i(x'') - X_i(x')| < L\|x'' - x'\|, \quad L = L_1(\|x''\| + \|x'\|)^{\alpha_1} \tag{1.2}$$

$$\|x(\theta)\| = \sup(|x_1(\vartheta)|, \ldots, |x_n(\vartheta)|) \quad \text{for} \quad -\tau \leq \vartheta \leq 0,$$

while L_1, α_1 are positive numbers. Let the equation

$$\Delta(\lambda) = \left| -E\lambda + \int_{-\tau}^{0} e^{\lambda\vartheta} d\eta(\vartheta) \right| = 0 \tag{1.3}$$

have a vanishing root $\lambda_1 = 0$, while for $j > 2$ it holds Re $\lambda_j \leq -2\alpha$ ($\alpha > 0$). Let $x_i(t + \vartheta)$, $-\tau \leq \vartheta \leq 0$ serve as an element of the trajectory $x_i(t)$ of (1.1). In the functional space $B\{x_i(\vartheta)\}$, $-\tau \leq \vartheta \leq 0$ to (1.1) there corresponds the ordinary system (cf. Ref. 5: N.N. Krasovskiy, Nekotorye zadachi teorii ustoychivosti dvizheniya [Some problems of the theory of stability of the motion] Fizmatgiz, 1959).

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On the stability in the critical case .....

$$\frac{dx_t(\vartheta)}{dt} = Ax_t(\vartheta) + R(x_t(\vartheta)), \qquad (1.4)$$

$$x_t(\vartheta) = (x_{1t}(\vartheta), \ldots, x_{nt}(\vartheta)) = (x_1(t+\vartheta), \ldots, x_n(t+\vartheta)),$$

$$A\varphi(\vartheta) = \begin{cases} \dfrac{d\varphi_i(\vartheta)}{d\vartheta} & (-\tau \leqslant \vartheta < 0), \\ \sum\limits_{j=1}^{n} \int\limits_{-\tau}^{0} x_j(\vartheta)\, d\eta_{ij}(\vartheta) & (\vartheta = 0), \end{cases}$$

$$R(\varphi(\vartheta)) = \begin{cases} 0 & (-\tau \leqslant \vartheta < 0), \\ X_i(\varphi_1(\vartheta), \ldots, \varphi_n(\vartheta)) & (\vartheta = 0). \end{cases}$$

The proof of stability of the solution $x_t(\vartheta) = 0$ of (1.4) is equivalent to the proof of stability of the solution $x = 0$ of (1.1). The author

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considers the functional

$$f[x_t(\vartheta)] = \sum_{j=1}^{n} \Delta_{jk_1}(0)\left[- x_j(0) + \sum_{l=1}^{n} \int_{-\tau}^{0} \left[\int_{0}^{\vartheta} x_{lt}(\xi)d\xi \right] d\eta_{jl}(\vartheta)\right] \qquad (1.5)$$

defined on the piecewise continuous $x(\vartheta)$. If $x_t(\vartheta)$ is a solution then it holds $f[x_t(\vartheta)] = f[x_0(\vartheta)]$. Let $\Delta_{ij}(\lambda)$ be the algebraic completion of the element of the i-th row and the j-th column of $\Delta(\lambda)$. Let $\Delta_{k_1 l_1}(0) \neq 0$. Let

$$\overline{b}(\vartheta) = \overline{\text{const}} = \{b_i\} = \left\{\Delta_{l_1, i}(0) \frac{1}{\Delta_{l_1 k_1}(0)\Delta'(0)}\right\} \qquad (1.6)$$

By the transformation

$$y = f[x(\vartheta)], \quad x(\vartheta) = z(\vartheta) + by \qquad (1.7)$$

(1.4) changes to

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On the stability in the critical case ....

$$\frac{dy}{dt} = Y(y, z_t(\vartheta)) ,$$

$$\frac{dz_t(\vartheta)}{dt} = Az_t(\vartheta) + Z(y, z_t(\vartheta), \vartheta) , \qquad (1.8)$$

$$Y = \sum_{j=1}^{n} \Delta_{jk_1}(0)X_j(z_t(\vartheta) + by), \; Z = R(x_t(\vartheta)) - bY$$

where the space B decomposes into a one-dimensional subspace l : $yb(\vartheta)$ and the functional space L with the index 1 : $z(\vartheta)$ so that $f[z(\vartheta)] = 0$. X
The author considers the system

$$Au(\vartheta) + Z(y, u(\vartheta), \vartheta) = 0 \qquad (1.9)$$

where $Z \in L$. Let $u^*(y,\vartheta) \in L$, $u^*(0,\vartheta) = 0$ be a solution of (1.9). By the transformation

$$z(\vartheta) = z_1(\vartheta) + u^*(y,\vartheta) \qquad (1.10)$$

(1.8) changes to
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$$\frac{dy}{dt} = Y_1(y, z_{1t}(\vartheta)) \qquad (1.11)$$

$$\frac{dz_{1t}(\vartheta)}{dt} = Az_{1t}(\vartheta) + Z_1(y, z_{1t}(\vartheta), \vartheta) \quad .$$

where

$$Y_1(y, z_1(\vartheta)) = Y(y, z_1(\vartheta) + u^*(y, \vartheta)) \qquad (1.12)$$

$$Z_1(y, z_1(\vartheta), \vartheta) = Au^*(y, \vartheta) + Z(y, z_1(\vartheta) + u^*(y, \vartheta)) - \frac{\partial u^*}{\partial y} Y_1(y, z_1(\vartheta)) \ .$$

In the present paper the author investigates the singular case $Y_1(y,0) \equiv 0$ and $Z_1(y,0,\vartheta) \equiv 0$ not investigated in (Ref. 7). In this case, (1.11) admits the solution

$$y = c \ , \quad z_{1t}(\vartheta) = 0 \qquad (2.1)$$

and (1.5) admits the solution

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On the stability in the critical case ....

$$x_t(\vartheta) = bc + u(c) \tag{2.2}$$

where c is an arbitrary constant.
The following theorems are proved under the assumption that the functionals x_i are analytic in y if analytic functions y and differentiable functions ϑ are substituted in them.
Theorem 1 : If by the transformations (1.7) and (1.10) the differential equations (1.5) of the disturbed motion can be written in the form (1.11) with $Y_1(y,0) = Z_1(y,0,\vartheta) \equiv 0$ then the undisturbed motion is stable. Here every disturbed motion being sufficiently little different from the undisturbed one tends, with an advancing time, to one of the steady motions of the family (2.2).
Theorem 1a : If (1.11) admits a functional integral of the form

$$Y + F(y, z_t(\vartheta), c) = c \tag{2.14}$$
$$(F(0, 0, 0) = 0) ,$$

where c is an arbitrary constant, $F(y,z_t(\vartheta),c)$ is a functional analytic in y and c which in the neighborhood of y = c = 0 admits an expansion in
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terms of integral powers of y and c which begins with second powers, and if F in $z_t(\vartheta)$ satisfies a Lipschitz condition the constant of which is arbitrarily small if $\| z_t(\vartheta) \| + |y(t)| + |c|$ is small, then the system (1.11) and (1.5) admit a family of steady solutions, i.e. there appears the singular case.

Theorem 2 : In the singular case, the system (1.11) and (1.5) admit a first functional integral of the form (2.14).

Theorem 3 : In the functional space there exists an integral surface L_1

$$y = F(y, z_t(\vartheta)) \tag{2.19}$$

(where F is of the type (2.14)) on which all solutions decrease asymptotically if the initial conditions y(0), $z_0(\vartheta)$ are sufficiently small with respect to the norm, and belong to the surface L_1 :

$$y(0) = F(y(0), z_0(\vartheta)) \quad .$$

If the assumption on the analyticity of the $X^0(y) \equiv X(x(y,\vartheta))$ is omitted then

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Theorem 4 : Let $Y_1^{(0)}(y) = Y_1(y,0)$ and $Z_1^{(0)}(y,\vartheta) = Z(y,0,\vartheta)$ be so that it holds uniformly in

$$\lim_{y \to 0} \frac{Z^0(y,\vartheta)}{Y^0(y)} \longrightarrow 0 \quad . \qquad (3.1)$$

If $Y^{(0)}(y)y < 0$, $|y| < \delta$, then the undisturbed motion $x = 0$ of the system (1.1) and (1.8) is asymptotically stable. If $Y^0(y)y > 0$, $|y| < \delta$ for $y > 0$ (or for $y < 0$) then $x = 0$ is unstable (δ is a sufficiently small number).
There are 7 Soviet-bloc references.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A.M. Gor'kogo (Ural State University imeni A.M. Gor'kiy)

SUBMITTED: February 8, 1960

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S/199/61/002/003/005/005
B112/B203

AUTHOR: Shimanov, S. N.

TITLE: The critical case of a pair of pure imaginary roots for systems with aftereffect

PERIODICAL: Sibirskiy matematicheskiy zhurnal, v. 2, no. 3, 1961, 467-480

TEXT: The author shows the equivalence of a stability problem with aftereffect in the critical case of a pair of pure imaginary roots with systems of ordinary differential equations of second order, and sets up stability conditions for the undisturbed motion in the critical case of a pair of pure imaginary roots. The system on which the study is based has the form:

$$\frac{dx(t)}{dt} = \int_{\tau}^{0} x(t+\vartheta)\,d\eta(\vartheta) + X(x(t+\vartheta)) \qquad (1.1)$$

where x(t) is an n-dimensional vector, and $\eta(\vartheta)$ an n-dimensional matrix

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of functions $\eta_{ij}(\vartheta)$ with bounded variation and the interval $[-\tau, 0]$ as domain of definition. $X(x(\vartheta))$ is a functional of the piecewise continuous function $x(\vartheta)$, which satisfies a Lipschitz-condition. The author considers the case of a pair of pure imaginary roots of the characteristic equation:

$$\Delta(\lambda) \equiv \left| -E\lambda + \int_{-\tau}^{0} e^{\lambda\vartheta} d\eta(\vartheta) \right| = 0.$$

The differential system equivalent to system (1.1) has the form

$$\frac{dx_t(\vartheta)}{dt} = Ax_t(\vartheta) + R(x_t(\vartheta))$$

$$y(\vartheta) = Ax(\vartheta) = \begin{cases} dx(\vartheta)/d\vartheta & \text{for } -\tau \leq \vartheta < 0 \\ \int_{-\tau}^{0} x(\vartheta) d\eta(\vartheta) & \text{for } \vartheta = 0 \end{cases}$$

$$R(x(\vartheta)) = \begin{cases} 0 & \text{for } -\tau \leq \vartheta < 0 \\ X(x(\vartheta)) & \text{for } \vartheta = 0 \end{cases}$$

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The critical case of a pair ... S/199/61/002/003/005/005
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with the substitution $x_t(\vartheta) = x(t+\vartheta)$, devised by N. N. Krasovskiy. After a number of further transformations, the author obtains the system (1.1) in a form which permits the application of a stability condition of I. G. Malkin. This condition makes the stability of the undisturbed motion x=0 dependent on the sign of the real part of an expansion coefficient. Finally, the author shows that an essential assumption of the stability condition derived is connected with the existence of a Lyapunov-transform. The author will continue this study in a second part. There are 7 references: 6 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publications reads as follows: Bellman R., On the existence and boundedness of solutions of nonlinear differential-difference equations, Ann. Math., 50, No. 2 (1949), 347 - 355.

SUBMITTED: January 29, 1960

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21337
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D299/[illegible]304

AUTHOR: Shimanov, S.N. (Sverdlovsk)

TITLE: On the stability of quasiharmonic systems with lag

PERIODICAL: Prikladnaya matematika i mekhanika, v. 25, no. 6, 1961, 992 - 1002

TEXT: A method is proposed for computing the characteristic exponents of systems of linear differential equations with lag and with almost-constant periodic coefficients. Stability criteria are formulated for the undisturbed motion of such systems. The quasi-harmonic system with lag

$$\frac{dx(t)}{dt} = (a + \mu g(t, \mu))x(t) + (b + \mu h(t, \mu))x(t - \tau) \qquad (1.1)$$

is considered; x - an n-dimensional vector, a, b - constant square matrices, g, h - matrices whose elements are analytic functions of μ and continuous functions of time t with period 2π, τ - the lag constant. The characteristic equation

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$$\Delta(\lambda) = /a + be^{-\lambda\tau} - E\lambda/ = 0 \qquad (1.2)$$

is considered, where E is the unit matrix. If among the roots of Eq. (1.2), there are several with zero real parts, then stability will be considerably affected by the functions g and h: the stability of the motion x = 0 of system (1.1) is considered for precisely this case. For each root λ of Eq. (1.2), a particular solution

$$x_s(t) = e^{\alpha t} u_s(t) \qquad (\alpha(0) = \lambda_1) \qquad (1.3)$$

of Eq. (1.1) can be constructed, where α is a constant with respect to t, and u_s - periodic functions of t. The constant $\alpha(\mu)$ is called the characteristic exponent. Below, a method is set forth whereby the characteristic exponents and the particular solutions of type (1.3) can be calculated. Two cases are considered, depending on λ_1 being a simple root or a multiple root. Assume λ_1 is a simple root. Then the particular solution is sought in the form (1.3) where

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$$\alpha_1(\mu) = \lambda_1 + \mu\alpha_1 + \mu^2\alpha_2 + \dots, \quad v_s(t, \mu) = u_s^{o}(t) + \mu u_s^{(1)}(t) + \dots \tag{2.1}$$

where α - unknown constants, u - unknown periodic coefficients. By virtue of Eq. (1.1), (1.3) and (2.1), one obtains

$$\frac{du^{(0)}}{dt} = au^{(0)}(t) + bu^{(0)}(t-\tau)e^{-\lambda_1\tau} - \lambda_1 u^{(0)}(t) \tag{2.2}$$

$$\frac{du^{(1)}(t)}{dt} = au^{(1)}(t) + bu^{(1)}(t-\tau)e^{-\lambda_1\tau} - \lambda_1 u^{(1)}(t) + g(t, 0)u^{(0)}(t) + h(t, 0)e^{-\lambda_1\tau}u^{(0)}(t-\tau) - \alpha_1 u^{(0)}(t) - bu^{(0)}(t-\tau)e^{-\lambda_1\tau}\tau\alpha_1 \tag{2.3}$$

The only periodic solution of (2.2) with period 2π, is the constant vector $x = \varphi_1$. One introduces $u^{(o)} = \varphi_1$ in system (2.3) and searches its periodic solution $u^{(1)}(t)$ with period 2π. These solutions are found, by the method of undetermined coefficients, in the form:

$$u^{(1)}(t) = c_1\varphi_1 + U^{(1)}(t)c. \tag{2.11}$$

Further, the case of multiple λ_1 is considered. Setting

$$U^{(0)} = M_1^{(0)}\varphi_1(t)+\ldots+ M_m^{(0)}\varphi_m(t) \qquad (2.12)$$

(where M are arbitrary constants) and introducing $u^{(o)}$ in Eq. (2.3) one obtains the equations for the periodic vector function $v(1)$. In order that these equations should allow periodic solutions, the m conditions

$$- \alpha_1(d_{j1}M_1^{(0)} +\ldots+ d_{jm}M_m^{(0)} + Q_{1j}M_1^{(0)} +\ldots+ Q_{mj}M_m^{(0)} = 0 \qquad (2.13)$$

have to be satisfied. In order that system (2.13) should allow a non-trivial solution, it is necessary and sufficient that its determinant vanish

$$/- \alpha_1 d_{jk} + Q_{kj}/ = 0. \qquad (2.14)$$

It is shown that Eq. (2.14) has degree m and m roots $\alpha_1^{(1)},\ldots, \alpha_1^{(m)}$. If the roots are distinct, m characteristic exponents

$$\lambda_j + \mu\alpha_1^{(j)} + \mu^2(\ldots)+ \ldots \qquad (2.15)$$

will correspond to them. If there are multiple ones among the roots, then the quantities $\lambda_j + \alpha_1^{(j)}\mu$ ($j = 1, \ldots, m$) are the first approximations to the characteristic exponents. By the method of undetermined coefficients, one obtains

$$u^{(1)} = M_1^{(1)}\varphi_1(t) + \ldots + M_m^{(1)}\varphi_m(t) + c\Phi^{(1)}(t), \qquad (2.16)$$

where Φ are periodic functions and M are constants. Introducing $u^{(1)}$ in the equations for $u^{(2)}$, one obtains the conditions for the existence of a periodic solution in the form

$$-\alpha_2 (d_{j1}M_1^{(0)} + \ldots + d_{jm}M_m^{(0)}) + Q_{1j}M_1^{(1)} + \ldots + Q_{mj}M_m^{(1)} - \\ -\alpha_1 (d_{j1}M_1^{(1)} + \ldots + d_{jm}M_m^{(1)}) + cA_j^{(1)} = 0 \quad (j = 1, \ldots, m) \qquad (2.17)$$

where A are given constants. The coefficients $u^{(2)}$, $u^{(3)}$ are found analogously to $u^{(1)}$. Construction of solutions (1.3) in the general case: After a change of variables, system (1.1) is written

$$\frac{du(t)}{dt} = au(t) + bu(t-\tau)e^{-\lambda_1\tau} - \lambda_1 u(t) + \mu g(t,\mu)u(t) + \\ + \mu h(t,\mu)u(t-\tau)e^{-\lambda_1\tau} + e^{-\lambda_1\tau}bu(t-\tau)(e^{-\varepsilon\tau} - 1) + \qquad (3.2)$$

$$+ \mu h(t, \mu) u(t - \tau) e^{-\lambda_1 \tau}(e^{-\alpha\tau}-1) - \alpha u(t), \quad (3.2)$$

where α has yet to be determined. The periodic solutions of (3.2) are sought. A system of integro-differential equations is considered. Two lemmas are proved which give the conditions for the existence of the periodic solutions. The second lemma states that for the system (3.2) to have periodic solutions, it is necessary and sufficient that system

$$W_j^* (M_1, \ldots, M_m, \mu, a) \equiv P_{j_1}(\mu, a) M_1 + \ldots + P_{jm}(\mu, a) M_m = 0$$
$$(j = 1, \ldots, m) \quad (3.6)$$

have non-trivial solutions. Stability of undisturbed motion x = 0 of (1.1): If all the m characteristic exponents have negative real parts, then system (1.1) is asymptotically stable; it is proved that every solution of (1.1) decreases exponentially for sufficiently small /μ/ ($\mu \neq 0$). There are 7 references: 5 Soviet-bloc and 2 non-Soviet-bloc. The references to the English-language publications read as follows: R. Bellman, On the existence and boundedness of

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solutions of nonlinear differential-difference equations. Annals of Mathematics, 1949, 50:2, 347-355; F.R. Moulton, Periodic orbits. Washington, Chap. I, 1920.

SUBMITTED: August 5, 1961

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SHIMANOV, S.N.

AID Nr. 986-9 10 June

STABILITY OF MOTION OF SYSTEMS WITH DELAYED ACTION (PARTICULAR CASE) (USSR)

Shimanov, S. N. Sibirskiy matematicheskiy zhurnal, v. 4, no. 2, Mar-Apr 1963, 457-470. S/199/63/004/002/011/013

The stability of motion of a system described by the equation

$$\frac{dx(t)}{dt} = \int_{-t}^{0} x(t+\vartheta)\,d\,\eta(\vartheta) + X[x(t+\vartheta)], \quad (1)$$

where $x(t)$ is an n-dimensional vector, (ϑ) is an n-dimensional matrix of the functions $\eta_{ij}(\vartheta)$, X is a functional satisfying the Lipschitz condition, and ϑ is a time delay taken from the interval $-t \leq \vartheta \leq 0$, is studied in the particular case when the characteristic equation has a pair of purely imaginary roots. In a functional space a system of "ordinary" differential equations corresponding to system (1) with operator-form right-hand sides is written which by introduction of the new conjugate variables y, $\bar{y}$ and the vector function $z(\vartheta)$ is reduced to a

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STABILITY OF MOTION OF SYSTEMS [Cont'd] S/199/63/004/002/011/013

form for which the method of solving the stability problem for ordinary differential equation can be applied in the particular case. The formal construction of the family of periodic solutions of this system is presented in the form of infinite series. It is shown that under certain conditions this solution is unique and that the series representing the solution are convergent. The stability of the nonperturbed motion $x = 0$ of system (1) in the particular case is proved in a manner similar to that employed for ordinary differential equations. It is proved that when the reduced system has a first integral in the form $y\bar{y} + \Phi(y, \bar{y}, z(\vartheta)) = \text{const}$, the particular case holds. An example, taken from the theory of automatic control, is presented. [LK]

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ACCESSION NR: AP3003239 S/0040/63/027/003/0450/0458

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AUTHOR: Shimanov, S. N. (Sverdlovsk)

TITLE: On the theory of differential equations with periodic coefficients and time lag

SOURCE: Prikladnaya matematika i mekhanika, v. 27, no. 3, 1963, 450-458

TOPIC TAGS: theory of differential equations, equations with periodic coefficients, equations with time lag, Krasovskiy method, monodromy operator asymptotic stability of motion, instability of motion, conjugate system

ABSTRACT: The following system of linear differential equations with delayed argument is studied by the method proposed by N. N. Krasovskiy in the functional space of continuous functions $C_{-\tau 0}$:

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$$\frac{dx_s(t)}{dt} = F_s(t, x_1(t+\vartheta), \ldots, x_n(t+\vartheta))$$

where

$$F_s(t, x_1(\vartheta), \ldots, x_n(\vartheta)) = \sum_{j=1}^{n} \sum_{\sigma=1}^{k} p_{sj\sigma}(t)\, x_j(-\tau_\sigma) + \sum_{j=1}^{n} \int_{-\tau}^{0} f_{sj}(t, \xi)\, x_j(\xi)\, d\xi \qquad (1)$$

$p_{sj\sigma}(t)$ are continuous functions with the period ω; $f_{sj}(t,\xi)$ are continuous with respect to both arguments on the intervals $-\tau \le \xi \le 0$ and $-\infty < t < +\infty$ and are periodic with respect to t with the period ω; and τ is time lag. The corresponding system of differential equations with the right-hand side in operator form is written, and the concept of the monodromy operator $U(\omega, t_0)$ is introduced. It is shown that the spectrum of this operator does not depend on t_0 and that eigenvalues of the operator $U(\omega, t_0)$ and the operator $U(\omega, t)$ are connected by a certain relation. It is established that the motion $x = 0$ is asymptotically stable when the modulus of eigenvalues of the monodromy operator is smaller than unity and unstable when the modulus is larger than unity. The conjugate system of linear differential equations with leading argument and periodic coefficients is studied along with system (1). Explicit expressions of first integrals of system (1) in terms of solutions of a conjugate

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ACCESSION NR: AP3003239 0

system are derived, and the relation between the spectra of monodromy operators of these two systems is established. The analytic form of eigenvectors and of particular solutions extended over the entire t-axis is presented. It is shown that from the space $C_{-\tau_0}$ in which solutions of (1) are analyzed, a periodic N-dimensional basis (N, a finite number) can be singled out such that the motion of (1) in the N-dimensional subspace defined by this basis can be described by the system of ordinary differential equations with constant coefficients. The norm of its solutions in the complementary subspace decreases faster than the exponent

$$L \exp t/_{\omega} \log \varepsilon, \quad (2)$$

where $\varepsilon < 1$ and L is a certain positive number. Orig. art. has: 44 formulas.

ASSOCIATION: none

SUBMITTED: 09Mar63 DATE ACQ: 23Jul63 ENCL: 00

Card 3/3

SHIMANOV, S. N. (Sverdlovsk)

"The stability of systems with delay".

report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow, 29 January - 5 February 1964.

L 52511-65 EWT(d) Pg-4 IJP(c)
ACCESSION NR: AP5012020 UR/0376/65/001/001/0102/0116

23
C

AUTHOR: Shimanov, S. N.

... linear differential equations with aftereffect

... Differentsial'nyye uravneniya, v. 1, no. 1, 1965, 102-116

... automatic control, difference equation, differential equation

... author considers a ... of linear differential difference equations

$$\frac{dx_s(t)}{dt} = \sum ... \quad (s = 1, \ldots, n) \qquad (1)$$

which occur in the study of automatic control systems. Underlying the investigation are certain facts which are true for the original and adjoint systems, the ... the first integral, and of the general solution of (1). The ... considering equations involving delay in ... [..., 3] as proposed by N. N. ... Zadachi ... ustoychivosti dvizheniya. Gostekhizdat,

Card 1/4

L 2511-
ACCESSION NR: AP5012020

SUBMITTED: 03Sep64 ENCL: 00 SUB CODE: NA

NO REF SOV: 000 OTHER: 001

Card 2/2

L 23306-66 EWT(d)/EWP(v)/EWP(k)/EWP(h)/EWP(l)

ACC NR: AP6010537 SOURCE CODE: UR/0376/66/002/003/0314/0323

AUTHOR: Markushin, Ye. M.; Shimanov, S. N.

ORG: Ural State University (Ural'skiy gosudarstvennyy universitet)

TITLE: On the convergence of optimal control of a countable system of differential equations

SOURCE: Differentsial'nyye uravneniya, v. 2, no. 3, 1966, 314-323

TOPIC TAGS: optimal control, time delay system, regulator analytic design

ABSTRACT: The problem of analytic design of optimal regulators (the concept introduced by A. M. Letov—the Letov problem) is analyzed in the case when the behavior of the control system is described by the system of differential equations with delayed argument

$$\frac{dx(t)}{dt} = ax(t-\tau) + u, \qquad (1)$$

where a and $\tau > 0$ are constants and u is the control function. N. N. Krasovskiy (Prikladnaya matematika i mekhanika, v. 2, no. 1, 1962, 39-51) has shown that such optimal control u exists and can be found

Card 1/3 UDC: 517.925.2

L 23306-66

ACC NR: AP6010537

at any instant t in the form of a linear functional of a function $x(\theta)$ which describes the behavior of the control system on the preceding interval of time $t - \tau \leq \theta \leq \tau$. It is indicated that since construction of an exact optimal control function is difficult, an approximate method is considered in which the control function is taken in the form of a series

$$u = \sum_{j=1}^{\infty} p_j y_j(\lambda_j; x(\theta)), \qquad (2)$$

where p_j are constant coefficients and y_j are linear functionals depending on the roots λ_j of the characteristics of system (1) without delay ($\tau = 0$). This method, which is based on the method of decomposing functional spaces developed by S. N. Shimanov (Prikladnaya matematika i mekhanika, v. 24, no. 1, 1960; and v. 27, no. 3, 1963), reduces the solution of the problem to the solution of the Letov problem for a finite system of ordinary differential equations. The problem of convergence of series (2) to the optimal control of the original problem is investigated. It is proved that the optimal control u_n for an arbitrarily large N is bounded and its upper bound does not

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L 23306-66

ACC NR: AP6010537

depend on the number N. It is shown that the remainder term of the series is majorized by a series of the form $\sum_n cn^{-2+\varepsilon}$. Orig. art. has: 57 numbered equations. [LK]

SUB CODE: 01/ SUBM DATE: 05Jun65/ ORIG REF: 005/ OTH REF: 001/
ATD PRESS: 4231

Card 3/3

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001549510007-9"

L 44168-66 EWT(d) IJP(c)

ACC NR: AP6023965 SOURCE CODE: UR/0376/66/002/004/0453/0462

28
B

AUTHOR: Prokop'yev, V. P.; Shimanov, S. N.

ORG: Ural State University im. A. M. Gor'kiy (Ural'skiy gosudarstvennyy universitet)

TITLE: The stability in the critical case of a double zero root for a system with aftereffects

SOURCE: Differentsial'nyye uravneniya, v. 2, no. 4, 1966, 453-462

TOPIC TAGS: motion stability, approximate solution, differential equation solution, LINEAR OPERATOR

ABSTRACT: A method is presented for investigating unperturbed motions of systems with aftereffects for the critical case of double roots. The following equation is analyzed

$$\frac{dx_i(t)}{dt} = \sum_{j=1}^{n} \int_{-\tau}^{0} x_j(t+\theta)\, d\eta_{ij}(\theta) + X_i\left(x_1(t+\theta), \ldots, x_n(t+\theta)\right) \quad (i = 1, \ldots, n), \tag{1}$$

where the integrals are interpreted in the sense of Stieltjes. A detailed formulation of the problem is followed by a description of the splitting of the linear operator, an investigation of the stability of the system in the general case, and a stability investigation of a special case. Two groups of solutions of the first approximation equation correspond to the double zero roots. Orig. art. has: 57 formulas.

/6

UDC: 517.934

Card 1/2

L 44168-66

ACC NR: AP6023965

SUB CODE: 12/ SUBM DATE: 29May65/ ORIG REF: 007

LS

Card 2/2

ACC NR: AP6030790 SOURCE CODE: UR/0376/66/002/008/1018/1026

AUTHORS: Markushin, Ye. M.; Shimanov, S. N.

ORG: Ural State University im. A. M. Gor'kiy (Ural'skiy gosudarstvennyy universitet)

TITLE: Approximate solution of the problem of analytic construction of a regulator for an equation with delay

SOURCE: Differentsial'nyye uravneniya, v. 2, no. 8, 1966, 1018-1026

TOPIC TAGS: perturbation theory, automatic control, automatic regulation, optimal control, APPROXIMATE SOLUTION

ABSTRACT: The authors consider

$$\frac{dx(t)}{dt} = ax(t-\tau) + m\xi, \quad (1)$$

which describes the perturbed motion of a system of automatic regulation. Here a and m are constants, $\tau > 0$ is delay, ξ is a control, a functional defined on continuous curves $x(t)$ $(t \geq 0)$, and is assumed to satisfy a Cauchy-Lipschitz condition

$$\|\xi[x'(t)] - \xi[x(t)]\|^{(h)} \leq L_\xi \|x'(t) - x(t)\|^{(h)}, \quad (2)$$

where

$$\|x(\vartheta)\|^{(h)} = \sup|x(\vartheta)| \quad [-\tau \leq \vartheta \leq 0]. \quad (3)$$

Card 1/2 UDC: 517.949.22

L 07942-67

ACC NR: AP6030790

The authors seek $\xi[x(\theta)]$ such that every solution with any initial function $\varphi(\theta)$

$$x_0(\vartheta) = \varphi(\vartheta) \quad [-\tau \leq \vartheta \leq 0] \qquad (4)$$

as $t \to \infty$ goes to 0, where the size of

$$I(\xi) = \int_0^\infty \{ax^2(t) + c\,\xi^2[x(t)]\}dt \qquad (5)$$

is required to be minimal (a and c are constants). A successive approximation scheme yielding convergence to an optimal control is given. "In conclusion it should be mentioned that this article was discussed at an inter-city seminar on the theory of controlled processes. The authors thank the leader of the seminar, Corresponding member N. N. Krasovskiy of the Academy of Sciences of the SSSR, for his valuable remarks." Orig. art. has: 40 formulas.

SUB CODE: 12/ SUBM DATE: 30Jul65/ ORIG REF: 014/ OTH REF: 002

Card 2/2

GRABOVETSKIY, Yu.; SHIMAROV, V.

Fire hazards of a gas burner. Pozh.delo 6 no.1:16 Ja '60.
(MIRA 13:5)

1. Starshiye mastera pozharno-ispytatel'noy stnatsii, Rostov-na-Donu.
(Gas appliances)

GRABOVETSKIY, Yu.; SHIMANOV, V.

Explosion-proof storage-battery lamp. Pozh.delo 7 no.6:11 Je '61. (MIRA 14:6)

1. Starshiye mastera pozharno-ispytatel'noy stantsii, g. Rostov-na-Donu.
(Petroleum industry—Fires and fire prevention)
(Safety lamp)

KOSAREV, A., inzh. (Rostov-na-Donu); SHIMANOV, V., starshiy master (Rostov-na-Donu)

Frictional electricity can be grounded. Pozh.delo 8 no.2:12 F '62. (MIRA 15:2)

(Fire engines--Safety measures)

SHIMANOV, V.

Incubators. Pozh.delo 9 no.3:11-13 Mr '63. (MIRA 16:4)

1. Starshiy master Rostovskoy pozharno-ispytatel'noy stantsii. (Poultry houses and equipment—Fires and fire prevention)

R-3

USSR/Diseases of Farm Animals. Pathology of Reproduction

Abs Jour : Ref Zhur - Biol., No 7, 1958, No 31148

Author : Shimanov V.G.
Inst : -
Title : Treatment of Gynecological Diseases in Karakul Sheep

Orig Pub : Karakulevodstvo i zverovodstvo, 1957, No 3, 53-55

Abstract : It was established that gynecological disorders occasion a high percentage of infertility in Karakul sheep (up to 60%). For the Treatment of Endometritis and vaginitis, a 1% solution of Synestrol, in a dose of 0.2-0.4 mol. once a day, was administered 3 times at intervals of 1-2 days between injections. Local therapy consisted on syringing the genital organs with $KMnO_4$, hypertonic solutions of neutral salts, and aqueous solutions of organic dyes (pyoktanin, rivanol, and methylene blue). The best therapeutic effect was obtained by the use of aqueous solutions of the organic dyes in combination with previous introduction of Synestrol. -- I.Ya. Panchenko

Card : 1/1

SHIMANOV, V. G.

Cand Biol Sci - (diss) "Estrogenic activity of the pasture plant Psoraleo drupacea Bge (ak-kuray)." Moscow, 1961. 22 pp; (Ministry of Agriculture RSFSR, Moscow Veterinary Academy); 180 copies; price not given; (KL, 7-61 sup, 229)

V'YUNOV, V.; SHIMANOVA, Z.; GORBACHEV, I.

Leather substites made of nitrocellulose. Pozh.delo 5 no.4:
11:12 Ap '59. (MIRA 12:5)
(Nitrocellulose)
(Leather substitutes)

SHIMANOVA, Z., inzh.

Preservation of material evidence. Pozh.delo 6:9 Mr '60.
(MIRA 13:6)

(Fires) (Evidence (Law))

SHIMANOVA, Z., inzh.

Hay dryers fired with liquid fuel. Pozh.delo 9 no.2:12-13 F '63.
(MIRA 16:3)

(Hay—Drying) (Agriculture—Safety measures)

V'YUNOV, V.I.; SHIMANOVA, Z.YE.

Explosion hazard of peat dust. Torf.prom.38 no.2:20-22 '61.
(MIRA 14:3)

1. Pozharno-ispytatel'naya stantsiya Ispolkoma Mosoblsoveta.
(Dust explosion)
(Peat)

V'YUNOV, V.I.; SHIMANOVA, Z.Ye.

Fire hazard in peat briquetting plants. Torf. prom. 38 no.4: 20-22 '61. (MIRA 14:9)

1. Pozharno-ispytatel'naya stantsiya Ispolnitel'nogo komiteta Moskovskogo oblastnogo soveta.
(Peat industry—Safety measures)

SHIMANOVA, Zinaida Yegorovna; BELKIN, A.S., doktor yurid. nauk, red.; GORBACHEV, I.N., red.; ZLOBINA, Z.P., red.izd-va; MAYOROV, V.V., tekhn. red.

[Technical expert examination of the causes of fires] Pozharno-tekhnicheskaia ekspertiza. Moskva, Izd-vo kommun. khoz.RSFSR, 1963. 85 p. (MIRA 16:12)
(Fire investigation)

SHIMANOVA, Z.Ye.

Fire hazards in the manufacture of polyurethan foams (plastic foams). Sbor. rab. pozh.-ispyt. sta. no.3:5-12 '63. (MIRA 17:7)

1. Pozharno-ispytatel'naya stantsiya Moskovskoy oblasti.

SHIMANOVICH, A.I.

SELISSKIY, A.B., professor; SHIMANOVICH, A.I.

Cutaneous nerves and Langerhans' cells in psoriasis. Vest.ven.i derm. no.2:32-36 Mr-Ap '54. (MLRA 7:4)

1. Iz Instituta teoreticheskoy meditsiny Akademii nauk BSSR (direktor - chlen-korrespondent Akademii nauk BSSR A.Yu.Bronovitskiy).
(Psoriasis)

SHIMANOVICH, A.M.

Tables for selecting building walls according to heat engineering requirements (for industrial, public and subsidiary buildings and apartment houses). Ved.i san.tekh. no.9:20 S '56. (MLRA 9:10)
(Heating) (Walls)

GORBULVE, S.S., SHIMANOVICH, A.N., FEDOROVA, L.G., ORLOVA, Z.I.

Prognostic significance of eosinophilia in the specific treatment of syphilis. Sbor.nauch.rab.Bel.nauch.-issl.kozhno-ven.inst. 4:247-250 '54 (MIRA 11:7)

(SYPHILIS)
(EOSINOPHILES)

SHIMANOVICH, A.N.

Early clinical symptoms of leiomyoma cutis. Sbor.nauch.rab.Bel. nauch.-issl.kozhno-ven.inst. 4:357-359 '54 (MIRA 11:7)
(SKIN--TUMORS)

PAVLOV, N.F., dots.; SHIMANOVICH, A.M.

Solusulphone (sulphetrone) in the treatment of leiomyoma of the skin. Sov. med. 21 no.7:131-133 Jl '57. (MIRA 12:3)

1. Iz kafedry kozhnykh i venericheskikh bolezney (zav. - dots. N.F. Pavlov) Belorusskogo instituta usovershenstvovaniya vrachey (dir. - prof. M.N. Zhukova).
(SKIN, NEOPLASMS, ther.
leiomyoma, ther., sulphetrone (Rus))
(SULFONES, ther. use
sulphetrone in skin leiomyoma (Rus))
(LEIOMYOMA, ther.
sulphetrone in skin leiomyoma (Rus))

SHIMANOVICH, A.N.

Some remarks on sulfone therapy in deramtology. Sbor.nauch.rab.Bel. nauch.-issl.kozhno-ven.inst. 6:253-258 '59. (MIRA 13:11)
(SULFONES)
(SKIN--DISEASES)

SHIMANOVICH, A.N., assistent

Clinical aspects of Dercum's disease. Sbor.nauch.rab.Bel.nauch.-issl. kozhno-ven.inst. 6:396-400 '59. (MIRA 13:11)
(ADIPOSE TISSUES)

SHIMANOVICH, A. N.; PYATNITSKAYA, V. S.; KHAZINA, B. N.; VOYTKOVICH, I. I.

Parenchymatous keratitis in acquired syphilis. Vest. derm. i ven. 36 no.7:67-68 Jl '62. (MIRA 15:7)

1. Iz kafedry dermato-venerologii Belorusskogo instituta usovershenstvovaniya vrachey (zav. - dotsent N. F. Pavlov) i Slutskoy polikliniki.

(SYPHILIS) (CORNEA—DISEASES)

SHIMANOVICH, I. L.

Shimanovich, I. L. -- "Investigation of Anode Deposits Obtained During the Electrolysis of Solutions of Some Silver Salts." Cand Chem Sci, Moscow City Pedagogical Inst, Moscow 1953. (Referativnyy Zhurnal--Khimiya, No 1, Jan 54)

So; SUM 168, 22 July 1954

SHIMANOVICH, I. L.

USSR/Chemistry

Card 1/1 : Pub. 151 - 3/42

Authors : Skanavi-Grigoryeva, M. C., and Shimanovich, I. L.

Title : Anodic depositions obtained during electrolysis of silver salts

Periodical : Zhur. ob. khim. 24/9, 1490-1495, Sep 1954

Abstract : The composition, structure and conditions favorable for the formation of anodic depositions, usually obtained during the electrolysis of aqueous $AgNO_3$, AgF, H_2O, $AgClO_4$, Ag_2SO_4, $AgClO_3$ and $AgC_2H_3O_2$-solutions, were investigated. It was established that the conditions favorable for the derivation of anodic depositions depend upon the amount of electrolyte used, its concentration and upon the forms and dimensions of the electrolyzer and electrodes. The composition of the anodic depositions and their relation to the current density, electrolyte concentration and temperature, are explained. Nine references: 3-USSR; 5-German and 1-French (1896-1953). Tables; illustrations.

Institution : The V. P. Potemkin Municipal Pedagogical Institute, Moscow

Submitted : February 19, 1954

SHIMANOVICH I. L

10

POKROVSKIY, I.I.; PAVLYUCHENKO, M.M.; SHIMANOVICH, I.Ye.

Diffusion of copper in the sulfide film formed on it. Dokl. AN BSSR 5 no.11:499-502 N '61. (MIRA 15:1)

1. Belorusskiy gosudarstvennyy universitet imeni Lenina.
(Copper sulfides) (Diffusion)

SHIMANOVICH, M.K.; NEVZOROV, N.V.

Continuous roller-type moisturizing and oiling machine. Kozh.-obuv.prom. 2 no.6:36 Je '60. (MIRA 13:9)
(Leather--Machinery)

SHI[illegible]OVICH, N. M.

Spravochnik po dopuskam, rez'bam i kalibram [Manual on tolerances, threads, and gages]. Izd. 2-e, [illegible]., Novosibirsk, Novosibgiz, 1952. 400 p.

SO: Monthly List of Russian Accessions. Vol. 6 No. 7 October 1953

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001549510007-9"

SOV/112-57-6-12562

Translation from: Referativnyy zhurnal. Elektrotekhnika, 1957, Nr 6, p 135 (USSR)

AUTHOR: Shimanovich, O. L.

TITLE: Outfit for Checking Multi-Range Volt-Ammeters
(Ustanovka dlya poverki mnogopredel'nykh vol'tampermetrov)

PERIODICAL: Inform. tekhn. sb. M-vo elektrotekhn. prom-sti SSSR, 1956, Nr 8 (92), pp 17-19

ABSTRACT: A checking outfit of the Krasnodar Plant of Electric Measuring Instruments is described. It comprises reference instruments that have a total of 48 measurement ranges, from 0.15 ma to 30 amp and 15 mv to 300 v DC, from 25 ma to 10 amp and from 1.5 to 300 v AC 50 cps. A system of signaling against incorrect connection of the reference instruments is provided.

M. Kh. Sh.

Card 1/1

8(0) SOV/112-58-3-4207

Translation from: Referativnyy zhurnal. Elektrotekhnika, 1958, Nr 3, p 108 (USSR)

AUTHOR: Shimanovich, O. L.

TITLE: Control of an Outfit for Magnetizing Permanent Magnets
(Upravleniye ustanovkoy dlya namagnichivaniya postoyannykh magnitov)

PERIODICAL: Inform.-tekhn. sb. M-vo elektrotekhn. prom-sti SSSR, 1956, Nr 9, pp 14-18

ABSTRACT: A relay circuit is described that controls a permanent-magnet magnetizing outfit. The outfit includes a stepdown transformer with one secondary turn that creates a magnetizing field. To secure cutting off the transformer at the most opportune moment, in terms of voltage amplitude and phase, a control circuit is provided consisting of four telephone-type relays, a step-by-step selector, and a selenium rectifier. The selector winding can be connected to the AC line, via a half-wave selenium rectifier, by a push-button. Current pulses advance the selector rotor in synchronism with the

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8(0)

SOV/112-58-3-4207

Control of an Outfit for Magnetizing Permanent Magnets

supply-voltage frequency; thus, the transition of the selector wiper from one group to another is definitely tied to the supply-voltage phase. Therefore, the moments of operation of two relays connected to the selector bank will also be tied with the supply-voltage phase. A magnetic starter that controls the transformer is switched on by one of these relay-switches and off by the other. Two other relays, one of which forms a pulse-couple with the step-by-step selector, serve to reset the circuit components. The magnetization intensity is stabilized by the following stable time parameters of the magnetic starter: high mechanical controlling torque, anti-vibration mounting on a brick wall, rigid construction, and the lowest possible moment of inertia of the starter armature.

V. Yu. K.

Card 2/2

SHIMANOVICH, S.L.

Use of the staining method of examining loess soils. Dokl. AN BSSR 5 no.3:122-124 Mr '61. (MIRA 14:3)

1. Institut geologicheskikh nauk AN BSSR. Predstavleno akademikom AN BSSR K.I. Lukashevym.
(Loess)

SHIMANOVICH, S.L.

Distribution of titanium in the cover sediments of the White Russian Polesye. Dokl. AN BSSR. 8 no.12:807-809 D '64. (MIRA 18:4)

1. Laboratoriya geokhimicheskikh problem AN BSSR.

BORODACHEV, I.P., kandidat tekhnicheskikh nauk; GARBUZOV, Z.Ye., inzhener; redaktor; GOROKHOV, B.N. laureat Stalinskoy premii, inzhener; KOSTIN, M.I., inzhener; POPOV, N.I., inzhener; PRUSSAK, B.N., inzhener; SHIMANOVICH, S.V., inzhener; PETERS, Ye.R., kandidat tekhnicheskikh nauk, retsenzent; KRIMERMAN, M.N., inzhener, redaktor; MODEL', B.I., tekhnicheskiy redaktor.

[Machines for constructing irrigation systems] Mashiny dlia sooruzheniia orositel'nykh sistem. Pod red. Z.E.Garbuzova. Moskva, Gos.nauchno-tekhn.izd-vo mashinostroitel'noi lit-ry, 1951. 236 p. (MLRA 9:1)
(Irrigation)

SHIMANOVICH, S.V.

KOSTIN, M.I.; SHIMANOVICH, S.V.; VERZHITSKIY, A.M., inzhener, retsenzent; BOYKO, A.G., inzhener, redaktor; TIKHONOV, A.Ya., tekhnicheskiy redaktor.

[Excavating machinery; handbook] Ekskavatory; spravochnik. Moskva, Gos. nauchno-tekhn. izd-vo mashinostroit. i sudostroit. lit-ry, 1954. 493 p. (MLRA 7:10)

(Excavating machinery)