

A88-11234 Stability of the steady motions of an electromagnetic tether system in orbit (Ob ustoyichivosti statsionarnykh dvizhenii elektromagnitnoi trosvoi sistemy na orbite). E. M. LEVIN, *Kosmicheskije Issledovaniia* (ISSN 0023-4206), Vol. 25, July-Aug. 1987, pp. 491-501. 10 Refs.

The motion of two satellites connected by a current-carrying tether in geocentric orbit is investigated. The interaction of the tether current with the geomagnetic field can either generate electric power or produce low thrust. The effect of electromagnetic forces distributed along the tether on the dynamics of the tether system is examined using a model of two material points connected by an extensible flexible thread. In the case of direct current, the presence of these forces leads to an instability of the steady motions of the tether system. Stabilization can be achieved by controlling the current force in the tether.

A88-11239 Effect of vibrations of elastic elements with distributed masses on satellite attitude (O vlianii kolebanii uprugikh elementov s raspredelennymi massami na orientatsiiu sputnika). S. I. ZLOCHEVSKII and E. P. KUBYSHKIN, *Kosmicheskije Issledovaniia* (ISSN 0023-4206), Vol. 25, July-Aug. 1987, pp. 537-544. 5 Refs.

A novel approach to the development of a mathematical model of a satellite with elastic elements with distributed masses is proposed. A closed boundary problem for elastic transverse beam vibrations, described by a partial integrodifferential equation, is formulated and solved. The effect of the vibrations on the satellite attitude is thus reduced to moments which are known functions of time applied to the central rigid satellite body. The results are of interest in connection with the influence of solar panels on satellite attitude.

A88-11244 Investigation of the electrostatic charging of a conducting shielded body on the Cosmos-936 satellite (Issledovanie elektrosticheskoi zariadki provodiashchego ekranirovannogo tela na ISZ "Kosmos-936"). E. E. KOVALEV, E. D. MOLCHANOV, V. K. LEBEDEV, T. IA. RIABOVA, I. G. PEKHTEREV et al., *Kosmicheskije Issledovaniia* (ISSN 0023-4206), Vol. 25, July-Aug. 1987, pp. 585-591. 13 Refs.

Experimental results are presented on the high-energy-electron electrostatic charging of a conducting body shielded against solar UV radiation and magnetospheric-plasma ions at heights of 200-400 km. It is shown that charge accumulated on the body can be stored for more than 100 hours. It is also demonstrated that high-voltage treatment is the main factor leading to an increase in the charging time and limiting the magnitude of the equilibrium potential.

A87-53523 Effect of geomagnetic field inhomogeneity on the dynamics of a shielded satellite (O vlianii neodnorodnosti geomagnitnogo polia na dinamiku ekranirovannogo sputnika). A. A. TIKHONOV, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), April 1987, pp. 67-73. 6 Refs.

A study is made of the effect of the inhomogeneity of the geomagnetic field on the stability of the relative equilibrium positions of an artificial satellite with a cylindrical electrostatic shield in circular equatorial orbit. The necessary and sufficient stability conditions are obtained. Regions of admissible satellite parameters are defined, and the effect of each component of the main moment of the Lorentz forces (resulting from the consideration of the inhomogeneity of the geomagnetic field in the shield volume) on the dimensions of the defined regions and satellite vibration frequencies are determined.

A89-10716 Physical/technical principles behind the development and application of spacecraft (Russian book) (Fiziko/tekhnicheskie osnovy sozdaniia i primeneniia kosmicheskikh apparatov). GENNADII PETROVICH DEMENT'EV, ALEKSANDR GRIGOR'EVICH ZAKHAROV, and IURII KONSTANTINOVICH KAZAROV, *Izdatel'stvo Mashinostroenie*, 1987, 264 pp. 217 Refs.

Various aspects of spacecraft design, development, and application are discussed, with some projections made concerning space programs up to the year 2000. Particular consideration is given to the functional design of spacecraft, the structural design and application of orbital complexes, the development of spacecraft with two-mode liquid rocket engines and low-thrust engines, the features of onboard computers, and advanced spacecraft construction materials.

A88-48084 Determination of loads in the aftereffect period for the compressed-gas catapult ejection of space probes (Opredelenie nagruzok v period posledestviia pri gazovom katapul'tirovanii apparatov). P. P. LOGACHEV and V. I. DEGTIARENKO, *Kosmicheskaja Nauka i Tekhnika* (ISSN 0321-4508), No. 2, 1987, pp. 36-39.

Catapult-ejection systems are used to separate probes (e.g., for atmospheric or planetary-soil studies) from the main spacecraft body. The compressed gas issuing from the catapult channel after the object has been ejected exerts a strong influence on the main body during the aftereffect period. In this paper, the Godunov method is used to calculate the relevant gasdynamic parameters for the aftereffect period, and it is shown that pressure pulses act on the main spacecraft body during the aftereffect period, which change depending on the ambient pressure.

Japanese Aerospace Literature This month: *Aircraft/Spacecraft CAD/CAM'S*

A89-23771 Simplified design techniques for laminated cylindrical pressure vessels under stiffness and strength constraints. HISAO FUKUNAGA and TSU-WEI CHOU, *Journal of Composite Materials* (ISSN 0021-9983), Vol. 22, Dec. 1988, pp. 1156-1169. 10 Refs.

This paper treats the optimum design of graphite/epoxy laminated composite cylindrical pressure vessels under stiffness and strength constraints based upon the membrane theory. Stiffness constraints are specified as strain conditions both in the axial and circumferential directions. Tsai-Wu failure criterion is used for determining a first-ply-failure strength. The stiffness and strength characteristics of the laminate are discussed based upon the concept of lamination parameters. For small values of allowable axial and circumferential strains, the strain (or stiffness) condition is critical, while for large values of allowable strains the strengths condition is critical. The optimal laminate configurations are determined for the various kinds of strain and strength.

A88-50200 Development of a graphic simulator augmented teleoperation system for space applications. K. MACHIDA, Y. TODA, T. IWATA, M. KAWACHI, and T. NAKAMURA, IN: AIAA Guidance, Navigation and Control Conference, Minneapolis, MN, Aug. 15-17, 1988, Technical Papers. Part 1 (A88-50160 21-08). Washington, DC, American Institute of Aeronautics and Astronautics, 1988, pp. 358-364. 6 Refs. (AIAA Paper 88-4095).

A teleoperation system augmented by a real time graphic simulator is proposed for efficient operation of a space teleoperator or telerobot, and is developed. An operator teaches the task sequences to a slave arm by driving the three dimensional graphic image of the arm on the simulator display, using an actual master arm. The sequences are stored and edited interactively, then the modified trajectories are transmitted to the slave arm. The flexible operation is realized by forward/reverse reproduction of variable time rate either on-line or off-line to the slave arm. In the simulator, the arm motion and interaction including the interference check and reconfiguration of primitives are computed in real-time, and the animation and the pseudoforce are fed back to an operator. This simulator is integrated with a slave manipulator system with the durability in vacuum environment and a master manipulator system with a universal hand-controller for space applications.

A88-31414 Optimum design of hybrid fibrous laminated composite plates subject to axial compression. MITSUNORI MIKI and KOUJI TONOMURA, IN: Composite structures 4; Proceedings of the Fourth International Conference, Paisley, Scotland, July 27-29, 1987. Volume 1 (A88-31401 12-24). London and New York, Elsevier Applied Science, 1987, pp. 1.368-1.377. 7 Refs.

A flexural lamination parameter diagram of hybrid fibrous laminates is constructed and a new analytical design method is proposed to determine the optimum lay-up of hybrid laminated plates subject to axial compression. The object of the design problem is to minimize the cost of the hybrid plates which have a composite surface with high performance and high cost, and a composite core with low cost, under the constraint that the plate has a given buckling strength. The optimum lay-up can be obtained from the material constants of the two kinds of unidirectional composites used, the plate aspect ratio, and the constraint on the buckling load.

A89-19943 Typical application of CAD/CAE in space station preliminary design. KATSUHIKO TAKAHASHI and YOSHIHARU HANAI, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 28, July 1988, pp. 197-201.

The role of CAD/CAE in the Japanese Experiment Module (JEM), Japan's contribution to the Space Station project, is examined. It is shown that CAD/CAE is significantly efficient in hardware layout design, component/structure interference analysis, window field of view analysis, manipulator operability analysis in equipment replacement, drawing development, data exchange with NASA and participating companies, and efficiency of data usage.

A89-16333 Recent trends in gearing technology. KIYOHICO UMEZAWA, *JSME International Journal*, Series III (ISSN 0914-8825), Vol. 31, June 1988, pp. 357-362. 10 Refs.

A novel method for predicting the vibration of a helical gear pair is described. A theoretical analysis on the vibration of a narrow facewidth helical gear pair is presented as well as a vibration simulation and a performance diagram of vibration. Manufacturing trends are discussed with attention given to the NC hobbing machine and topological modification.

A89-23379 Curves and surfaces in computer aided geometric design (Book). FUJIO YAMAGUCHI, Berlin and New York, Springer-Verlag, 1988, 389 pp.

The treatment of curved surfaces in geometric CAD is examined in a textbook and reference guide for graduate engineering students. Chapters are devoted to the mathematical description of shape information, the basic theory of curves and surfaces, Lagrange interpolation, Hermite interpolation, spline interpolation, the Bernstein approximation, the B-spline approximation, and rational polynomial curves. Diagrams, graphs, and sample computer-generated images are provided.

A89-13825 Modelling of flexible manipulator arms. SHOZO TSUJIO, IN: System modelling and optimization; Proceedings of the Thirteenth IFIP Conference, Tokyo, Japan, Aug. 31-Sept. 4, 1987 (A89-13816 03-63). Berlin and New York, Springer-Verlag, 1988, pp. 277-286. 14 Refs.

A three-dimensional lumped-parameter FEM dynamical modeling technique for multiple-flexible-link manipulator arms is developed analytically. The equations of motion are derived using a Lagrangian approach, treating the large articular motion and the small elastic displacement separately and coupling the resulting equations via the inertial mass. The derivation of the method is outlined, and the implementation of a simulation algorithm is discussed. The method is shown to facilitate the intuitive understanding of the arm kinematics and dynamics while simplifying the numerical operations required for CAD applications.

A88-54665 Array optimization and its application to control problems. KIYOTAKA SHIMIZU and MASAKAZU SUZUKI, IN: 1988 American Control Conference, 7th, Atlanta, GA, June 15-17, 1988, Proceedings. Volume 3 (A88-54401 24-63). New York, Institute of Electrical and Electronics Engineers, 1988, pp. 2305-2311. 7 Refs.

In order to develop an analysis technique for distributed parameter systems (DPSs), a generalization of a vector-matrix array is introduced, and an array algebra is constructed which generalizes the concepts of conventional vector systems to those of array systems. An optimization problem for an array dynamical system is formulated, and the necessary optimality condition is derived by using the array algebra. Array dynamical systems are obtained when a wide class of DPSs is approximated using the finite-element or finite-difference method, and the state distribution of the DPS is expressed. An linear-quadratic (LQ) problem for a linear-array dynamical system is investigated, and an optimal control is obtained which is the array version of the well-known LQ optimal control and realizes a sort of feedback of the state distribution pattern of the DPS. The array introduced provides a technique for developing more advanced pattern feedback controls for DPSs.

A88-32522 Applications of artificial intelligence in Japan. NAKAJI HONDA and ARIO OHSAITO, *Telematics and Informatics* (ISSN 0736-5853), Vol. 5, No. 1, 1988, pp. 39-52. 21 Refs.

This article presents a comprehensive report on the recent research and development of artificial intelligence (AI) in Japan, focusing especially on industrial applications. First, historical background of AI research and the future trends of AI Marketing in Japan are reported. Then, industrial applications of AI are introduced with respect to three fields: expert systems, machine translation, and applications of fuzzy set theory. Finally, problems for future research projects are outlined.

A88-34460 Design and fabrication of 20 percent-efficiency, medium-resistivity silicon solar cells. T. SAITO, T. UEMATSU, K. MATSUKUMA, Y. KIDA, and K. MORITA, IEEE, Proceedings of the 19th Photovoltaic Specialists Conference, New Orleans, LA, May 4-8, 1987, (A88-34226 13-44). New York, Institute of Electrical and Electronics Engineers, Inc., 1987, pp. 1518, 1519. Research supported by the New Energy Development Organization of Japan. 5 Refs.

High-efficiency silicon solar cells were designed using a computer simulation program based on experimental minority-carrier lifetimes. It was estimated that back-surface-field cells using medium-resistivity substrates provide the highest conversion efficiency. Cells fabricated using medium-resistivity float-zone substrates and optimized by developing a back-surface-field process to maintain a high minority-carrier lifetime. An improved passivated V-grooved surface enhances collection efficiency. The resulting cells exhibit conversion efficiencies of 20.5 percent with a short-circuit current density of 39.3 mA/sq cm. The minority-carrier lifetime obtained from the photoreponse curve is calculated to be 340 microsec, which means that the solar cells were fabricated under substantially clean processes.

A86-39794 On a microcomputer integrated system for structural engineering practices. W. KANOK-NUKULCHAI, *Computers and Structures* (ISSN 0045-7949), Vol. 23, No. 1, 1986, pp. 33-37. 9 Refs.

This paper describes a comprehensive use of microcomputer for professional practices of structural engineers. Transition from the conventional method to a computer-based procedure calls for a complete rethinking of an accurate, unambiguous definition of all the elementary activities, their logical orders as well as inter-relationships. An integrated database software system is then proposed for analysis and design of structures, on microcomputer. With a common data bank, all previously processed data can serve directly as a basis for subsequent activities, such as computer-aided drafting, computer-aided construction planning, etc. Several program strategies to attain a maximum efficiency within existing microcomputer constraints are discussed.

A88-19653 A microcomputer program for stress analysis of adhesive-bonded joints. S. AMIJIMA and T. FUJII, *International Journal of Adhesion and Adhesives* (ISSN 0143-7496), Vol. 7, Oct. 1987, pp. 199-204. 5 Refs.

A simple finite element algorithm and a program written in BASIC are presented which can be used to calculate normal and shear stresses in the adhesive layer of adhesive-bonded structures. The method allows for the thermal expansion of the adherends and for the shrinkage of the adhesive. The program is demonstrated for two specific cases, a single lap joint and a sandwich-beam cantilever.

A88-18645 Application of an inverse cascade design method to an axial fan. AKIRA GOTO, *JSME International Journal* (ISSN 0913-185X), Vol. 30, Sept. 1987, pp. 1414-1422. 9 Refs.

In order to demonstrate the applicability of an inverse cascade design method for blade design for an axial turbomachine, rotor and stator blades of a single stage axial fan are designed and tested. This design concept, proposed in the previous reports, is based on an inverse boundary layer method and an inverse cascade method. The overall performance and the rotor exit flow are measured and are compared with those of a conventional fan designed using an NACA 65 series cascade. The inversely designed fan obtains higher efficiency and a wider operating range compared with the conventional one. The rotor blade midspan wake in the trailing edge region reveals an extremely low velocity defect, a low wake shape factor, and low momentum thickness. Boundary layer separation on the rotor blade surface seems to be avoided and the losses are low. The experimental results show the validity of the practical application of the inverse design concept, especially for rotating blades.

A87-51981 On design of restructurable control systems for aircraft with some failures. KIMIO KANAI and YOSHIMASA OCHI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, No. 401, 1987, pp. 311-317. 7 Refs.

Computer simulations of a model of a large scale aircraft are used to design an aircraft control system which automatically restructures itself to accommodate failures and to restore safety and performance. The case of a broken vertical tail and failure of the hydropressure system is considered. The effects of the vertical tail breakage on the dynamic characteristics of the aircraft, and the effectiveness of thrust control using an optimum regulator, are evaluated. A restructurable control system composed of parameter identification and optimal regulator subsystems is then designed.

A87-46550 An approach to nonlinear fracture mechanics using. MASAHIRO ADINA IKEDA and TATSUHIKO AIZAWA, *Computers and Structures* (ISSN 0045-7949), Vol. 26, No. 1-2, 1987, pp. 223-231. 10 Refs.

A postprocessor for the ADINA program has been developed to calculate J-integral and J-integral values. The postprocessor can deal with relatively complex fracture mechanical behaviors with plastic strains, thermal strains, inertia forces and body forces taken into account. This paper presents the results of two fracture mechanical analyses of the center-cracked plate. These results indicate that the J-integral can be considered path-independent even in the presence of plastic strains and inertia forces, and that it can hold a constant value during the stable crack growth.

A86-48136 Extensive verification of the Denton new scheme from the user's point of view. II - Comparison of calculated and experimental results. T. SATO, S. AOKI, and T. NAGAYAMA, ASME, 31st International Gas Turbine Conference and Exhibit, Duesseldorf, West Germany, June 8-12, 1986. 8 pp. 5 Refs. (ASME Paper 86-GT-58).

A blade-to-blade flow program incorporated in the computer-aided turbine design system is required to have short run times, robustness, and no limitations. The Denton time-marching method (1982) is attractive as it is fast and can handle mixed subsonic-supersonic flows. In this paper, the scheme is extensively verified by comparing calculated surface Mach number distributions with experimental data obtained from two-dimensional cascade tests for 23 cascades. For the nozzles, excellent agreement is obtained if the flows are fully subsonic, or if they are transonic with weak shock-boundary layer interaction. For the blades, very good agreement is also obtained if the blades have moderate blade reaction and viscous effects are small. Satisfactory results are obtained for suction surface diffusion, even at off-design inlet conditions, if absolute values of incidence angle are less than 10 deg.

A86-43061 A study on robot path planning from a solid model. Y. ITOH, M. IDESAWA, and T. SOMA, *Journal of Robotic Systems* (ISSN 0741-2223), Vol. 3, Summer 1986, pp. 191-203. 6 Refs.

In an effort to improve current CAD/CAM circumstances, a trial CAE system which generates the operation path of a robot from a solid-model built-in CAD process, has been examined. In this system, solid models are built by performing set operations such as addition, subtraction, and intersection between several primitives or solid models. Processing is made for a solid model represented by B-rep (boundary representation). To ease the processing, curved faces such as spherical, cylindrical, or conical surfaces, are approximated by several flat planes. As a first step, by assuming Gaussian spatial distribution for a painting gun, path planning of a painting robot for a convex solid body has been examined. A scanning plane is defined for each flat plane and a path of robot effector is generated on this plane.