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DEMONSTRATION OF FLEXIBLE SPACECRAFT CONTROL DESIGN SOFTWARE AND TECHNIQUES -- FINAL REPORT

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Spar Aerospace Limited
Remote Manipulator Systems Division
1700 Ormont Drive, Weston, Ontario, Canada M9L 2W7

SPAR Space & Electronics Group

TEL. (416) 745-9680 TELEX 065-27360 SPARORM TOR TWX 610-491-1503 CABLE-SPARORM TOR

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APPROVALS

R. Ravindran Section Chief, Controls and Analysis
H.F. Barker Manager, Controls and Analysis
S.S. Sachdev Manager, System Controls and Analysis
P.A. McIntyre Director of Engineering

PREPARED BY J.S-C. Yuan
Staff Engineer

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Spar Aerospace Limited
Remote Manipulator Systems Division
1700 Ormont Drive, Weston, Ontario, Canada M9L 2W7

SPAR Space & Electronics Group

TEL. (416) 745-9680 TELEX 065-27360 SPARORM TOR TWX 610-491-1503 CABLE-SPARORM TOR

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AUTHOR(S): J.S-C. YUAN

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PREPARED BY: Spar Aerospace Ltd.
1700 Ormont Drive,
Weston, Ontario,
Canada M9L 2W7

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DEMONSTRATION OF FLEXIBLE SPACECRAFT CONTROL DESIGN SOFTWARE AND TECHNIQUES - FINAL REPORT

SUMMARY

This report contains the result of a study conducted to demonstrate the capabilities of the computer-aided control system design package KEDDC. The design problem concerns the robust control of flexible spacecraft using, specifically, estimator-based compensation. The results from this study demonstrate that it is possible to obtain a robust design of an estimator-based compensator for either regulation or tracking purposes.

The report begins with verification results obtained for an optimal regulator designed in a previous study for the MSAT model. The design is then further iterated using KEDDC to arrive at a compensator which is robust in the presence of all the residual modes of the evaluation model. This is done through a simple technique which searches among a class of optimal compensator candidates until a robust solution is obtained.

The same methodology is subsequently applied to a robust tracking problem which, in addition to stability, also requires the output to follow a non-zero set point in the presence of external disturbances and parametric uncertainties. The success of the method is demonstrated with a compensator design for a model of MSAT with 7 control inputs and outputs, 16 measurements and 15 disturbance inputs. The design model is based on all 5 rigid body modes and 4 of the 11 elastic modes of the evaluation model. The properties of stabilization, steady state tracking, disturbance rejection and robustness are all retained when the compensator is applied to the evaluation model. In particular, results from sensitivity analysis indicate that the design performance is insensitive to the numerical accuracy of the controller gains and variations in the estimator parameters.

Finally, this report describes an attempt to adapt a recently developed multivariable robustness theory to the design of flexible spacecraft control systems. The theory provides singular value-based design criteria which guarantee robustness with respect to a broad class of structured or unstructured perturbation dynamics. It is found that the commonly-published robustness criteria are not suitable for compensators with integral feedback such as the type considered here. A modified robustness criterion is developed in this report. The potential of this criterion as a design tool is partially demonstrated with a single input-single output example extracted from the MSAT model.

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1.0 INTRODUCTION

This is the final report on the study: "Installation and Demonstration of Spacecraft Control Design Software and Techniques" conducted under Contract No: DSS/06ST.36001-3-2484, Ser. OST83-00215.

The main tasks of the study are the following:

(a) To transfer and adapt for execution on the CRC Honeywell CP-6 computer the control design programs developed under an earlier contract (15ST-36100-1-0102).

(b) To evaluate selected design results from the previous study by making use of a computer-aided control system design package (KEDDC) resident in the CP-6 system.

(c) To further iterate the previous design so as to obtain a compensator capable of stabilizing the MSAT evaluation model.

(d) To design a robust tracking compensator for the benchmark model provided in Ref. [1].

(e) To develop a robustness design criterion for flexible spacecraft.

An important emphasis throughout this study is to fully utilize the computational capabilities of the design package KEDDC (Ref. [2]).

Task a culminates in a users' guide (Ref. [3]) for the control design programs documented in Ref. [4]. The results for Tasks b - e are discussed sequentially in the remainder of this report.

2.0 EVALUATION OF DESIGN RESULTS WITH KEDDC

This section describes the design results obtained with KEDDC for the data taken from Ref. [4]. Specifically, the following three design cases have been studied:*

(a) Discrete-time full-state feedback regulator with the quadratic cost weighting matrices ($\mathcal{Q}$, $\mathcal{R}$) taken from the continuous-time model.

(b) Same as (a) but with discretized weighting matrix .

(c) Continuous-time decoupled observer design with spillover suppression.

The above cases correspond to the design cases RICMATF, RICQF and DECMATS, respectively, described in Appendix A of Ref. [4]. For ease of reference, Table 2-1 lists the locations in this report where these design results are to be found.

The model data used here has been extracted from the data base of Ref. [4]. The design model consists of seven rigid body modes (2 translational and 5 rotational) together with modes 1,3,4 and 6 of the elastic modes. Appendix A lists the system matrices (A_e, B_e, C_e) for the continuous-time design model. Also listed are their discretized version ($\bar{A}_e$, $\bar{B}_e$, $\bar{C}_e$) obtained at 10 sec sampling period with KEDDC.

Cases (a) and (b) consider the design of a full-state linear feedback regulator for the discrete-time design model. The only difference between the two cases lies in the state weighting matrix of the quadratic cost function. In Case (a), the matrix is the Dynacon version (Ref. [9]) augmented with two additional diagonal elements corresponding to the translational modes; in Case (b), this matrix is discretized with KEDDC-supplied routines. The control input weighting matrix remains the same in both cases.

---

*It is assumed henceforth that the reader is already familiar with the theoretical background and notation of the control problem at hand. See Refs. [4] and [5] for details.

In the previous study, an integration (Euler's) method was used to compute the steady state Riccati solution for the feedback gains. The KEDDC method adopted here is based on a Schur vector method. Comparing the results from Appendices B-1, B-2 and C-1, C-2, we see that although the feedback gain matrix elements are quite different, the closed-loop design system is asymptotically stable in both cases. The apparent discrepancies in the controller gains could be attributed to the relatively crude iterative method used in the previous study in which the convergence error threshold was set at 1E-5. On the other hand, the KEDDC routine sets all error thresholds by default to 1E-6. Thus, it is entirely possible that the earlier Riccati solution may not have reached its steady state prior to termination.

A true comparison is difficult to draw in Case (c) for the observer design. The earlier results were based on a specific partitioning of the observer structure into a 14-th order rigid body observer and an 8-th order observer for the elastic modes. The rigid body observer was further decoupled into seven 2-nd order systems. The structure that results is presented in Appendix B-3. Unfortunately, KEDDC does not permit such flexibility in structural partitioning by the user. Instead, it performs its own partitioning internally in the program based on the observability indices so that each subsystem may be observed from a single output. As a consequence, the design that results (Appendix C-3) is not strictly comparable to the previous design even though the eigenvalues have again been set at $-0.27 \pm j\, 0.1308$.

In conclusion, this exercise has fully demonstrated the potential capabilities of KEDDC as a design tool. It should be noted that all the above design results have been obtained at a fraction (easily 10 to 1 !) of the time it took to produce the equivalent set of results in the previous study.

TABLE 2-1 Location Reference for Design Comparison

DESIGN PARAMETERS	APPENDIX REFERENCE	
	KEDDC RESULTS	PREVIOUS RESULTS
Case a)		
State Weighting Matrix	Appendix C-1	Appendix B-1
Feedback Matrix	,,	,,
Design Model Closed-loop Eignevalues	,,	,,
Case b)		
State Weighting Matrix	Appendix C-2	Appendix B-2
Feedback Matrix	,,	,,
Design Model Clodes-loop Eigenvalues	,,	,,
Case c)		
Observer System Matrix	Appendix C-3	Appendix B-3
Gain Matrix	,,	,,
Input Matrix	,,	,,
Observer Eigenvalues	,,	,,

3.0 DEMONSTRATION OF A ROBUST REGULATOR DESIGN WITH ESTIMATOR FEEDBACK

In this section, we continue the design iteration on the model studied in the last section. In particular, we shall carry the regulator problem posed in Ref. [5] to its logical conclusion by obtaining a compensator which remains stable when applied to the evaluation model. The only departure made from the earlier study is the use of the continuous-time model throughout the design. In the process of doing so, we shall demonstrate a simple, yet effective, technique of searching among the optimal compensator candidates for a robust solution.

3.1 PROBLEM FORMULATION

Let the evaluation model be described by the equations

$$\begin{aligned} \dot{x}_p &= A_p x_p + B_p u \\ y &= C_p x_p \end{aligned} \qquad (3\text{-}1)$$

where*

$$x_p := \begin{bmatrix} \eta_r \\ \dot{\eta}_r \\ \eta_e \\ \dot{\eta}_e \end{bmatrix} ; \quad u := \begin{bmatrix} g_1 \\ g_2 \\ f_1 \\ \vdots \\ f_8 \end{bmatrix} ; \quad y := \begin{bmatrix} \underline{\omega}_b \\ \underline{\theta}_b \\ \underline{\beta} \\ f'\underline{\delta} \\ \underline{\alpha} \end{bmatrix}$$

Here, the state vector consists of 7 rigid body modes (η_r) and 11 elastic modes (η_e) together with their rates. The control inputs are composed of 2 gimbal torques (g_1 , g_2) and 8 thruster forces (f_i). The outputs comprise the bus translation ($\underline{\omega}_b$) and attitudes ($\underline{\theta}_b$), the gimbal angles ($\underline{\beta}$) as well as the relative displacement ($f'\underline{\delta}$) and rotation ($\underline{\alpha}$) of the dish with respect to the bus. The system matrices (A_p, B_p, C_p)for the evaluation model (3-1) are listed in Appendix D.

As in Ref. [5], the design model is obtained by retaining only four of the eleven elastic modes in η_e , resulting in the following equations:

$$\begin{aligned} \dot{x}_c &= A_c x_c + B_c u \\ y &= C_c x_c \end{aligned} \qquad (3\text{-}2)$$

The system matrices (A_c , B_c , C_c) are also listed in Appendix D. Table 3-1 compares the open-loop eigenvalues of the evaluation and design models.

---

*The reader is referred to Ref. [5] for notation.

The **robust estimator-feedback regulator problem** is then to find a compensator of the form

$$u = -F\hat{x}_c$$
$$\dot{\hat{x}}_c = A_c\hat{x}_c + B_c u + K(y - C_c\hat{x}_c) \qquad (3\text{-}3)$$

for the design model (3-2) which also stabilizes all the states of the evaluation model (3-1) in closed-loop. The term "estimator" is used here loosely and refers to any dynamic system of the form described in (3-3) regardless of how its parameters are obtained. Obviously, either a Kalman filter or a Luenberger observer will be permitted.

As done previously, we continue to consider an optimal approach to computing the feedback gain F of the controller by minimizing a quadratic cost function of the form

$$J = \int_0^\infty (x_c^T Q x_c + u^T R u)\, dt \qquad (3\text{-}4)$$

where Q and R are appropriately selected weighting matrices. The feedback gain is then obtained via the steady state solution of an algebraic matrix Riccati equation. Several options for this solution are available from KEDDC.

A pole assignment algorithm was used in Ref. [4] to compute the observer gain K by setting all of its poles to a specific value. This unfortunately resulted in a compensator design which was unstable when applied to the evaluation model. Hence, setting all the observer poles to the same value is clearly a poor choice from the robustness standpoint.

Here we shall adopt an optimal approach (i.e., Kalman filter) to calculating the estimator parameters. As it turns out, the solution is virtually identical to the optimal control solution for the feedback gain described above. The weighting matrices (Q , R), however, must be replaced by the intensity matrices of the random input disturbances and measurement noises, both of which are assumed to be uncorrelated zero-mean white noise processes. The exact procedures for the solutions to the optimal control and optimal estimator problems are described in any standard textbook on modern control theory (see, e.g., Ref. [6]). Only the design results are presented below.

3.2 DESIGN RESULTS

For the optimal control problem, we select the same weighting matrices (Q , ρR) from Appendix C-1, with the input weighting matrix, however, modified by a multiplication factor, ρ , which is a positive scalar constant. In the absence of any information on the input disturbances or measurement noises, we arbitrarily set the intensity matrices at

$$V_1 = \rho I$$

for the disturbance input, and at

$$V_2 = \rho I$$

for the measurement noise, where ρ is the same scalar constant applied to the control input weighting matrix.

The design procedure is then to search among the steady state Riccati solutions for the controller and the estimator over a range of values for ρ until a compensator which stabilizes the evaluation model (3-1) is obtained. In doing so, one relies upon the intuition that the effective system "bandwidth" decreases as ρ increases, which in turn reduces the spillover effects from the high-frequency modes. Although brute-force in appearance, this search approach has turned out to be very effective as the following results will show.

Table 3-2 lists the evaluation model closed-loop eigenvalues for values of ρ over the range

$$10^{-10} \leq \rho \leq 10^{-5}$$

It is seen that robustness to spillover is achieved for $\rho \geq 10^{-7}$. Below this value, the interaction from the residual modes of the evaluation model becomes severe enough to destabilize the system. The compensator parameters for a typical case ($\rho = 10^{-6}$) are listed in Appendix E.

It is perhaps worthwhile to compare the estimator-feedback compensator obtained here to the multivariate proportional-rate-integral controller described in Ref. [7]. Judging from the closed-loop eigenvalues of the two designs (cf. Table 5-1 in Ref. [7]), one concludes that the dominant time response of the estimator-feedback compensated system is almost two orders of magnitude faster than that of the proportional-rate-integral controlled system. There is of course a price to be paid for fast transient responses: complexity; in this case, 22 integrators are required for the estimator-feedback compensator.

The only control problem considered here is stabilization. Tracking of non-zero set points and disturbance rejection -- problems studied in Ref. [7]-- in general require additional dynamics in the compensator. These are the problems we shall address in the remainder of this report.

TABLE 3-1 Open-loop Eigenvalues of Evaluation and Design Models for the Regulator Problem

	EVALUATION MODEL		DESIGN MODEL
RIGID BODY MODES	0.0 (repeated 14 times)	CONTROLLED	0.0 (repeated 14 times)
ELASTIC BODY MODES	−9.230E−4 ±i 0.1244 −1.705E−3 ±i 0.2395 −8.558E−3 ±i 0.5563 −2.109E−2 ±i 0.7792	CONTROLLED	−9.230E−4 ±i 0.1244 −1.705E−3 ±i 0.2395 −8.558E−3 ±i 0.5563 −2.109E−2 ±i 0.7792
	−1.17422 ±i 13.803 −0.52431 ±i 10.045 −5.275E−2 ±i 3.9557 −2.802E−2 ±i 3.1373 −7.510E−2 ±i 1.5519 −5.532E−3 ±i 0.6902 −8.530E−4 ±i 0.1512	RESIDUAL	

TABLE 3-2 Closed-loop Eigenvalues of Evaluation Model with Estimator-Feedback Compensator

	ρ = 1.0E-5	ρ = 1.0E-6
RESIDUAL MODES	-1.174230 ±i 13.8027	-1.173510 ±i 13.8027
	-0.524340 ±i 10.0452	-0.523723 ±i 10.0448
	-5.285E-2 ±i 3.95570	-4.996E-2 ±i 3.95626
	-2.801E-2 ±i 3.13728	-2.872E-2 ±i 3.13684
	-7.577E-2 ±i 1.55198	-6.626E-2 ±i 1.55527
	-5.522E-3 ±i 0.69187	-1.269E-2 ±i 0.70032
	-2.773E-3 ±i 0.14913	-1.243E-2 ±i 0.15096
CONTROLLED MODES (including compensator)	-6.004E-2 ±i 0.781959	-0.172946 ±i 0.806302
	-3.075E-2 ±i 0.779058	-8.327E-2 ±i 0.776150
	-9.651E-2 ±i 0.557533	-0.274936 ±i 0.585529
	-1.515E-2 ±i 0.556762	-3.916E-2 ±i 0.562128
	-8.653E-2 ±i 0.262773	-0.194502 ±i 0.297490
	-1.623E-2 ±i 0.239990	-0.254308 ±i 0.227255
	-0.130327 ±i 0.124818	-0.210302 ±i 0.215214
	-0.120781 ±i 0.122468	-5.534E-2 ±i 0.245386
	-2.505E-2 ±i 0.129034	-9.206E-2 ±i 0.168154
	-3.122E-2 ±i 0.118811	-5.405E-2 ±i 0.168377
	-5.817E-2 ±i 0.100927	-0.112358 ±i 0.126267
	-7.067E-2 ±i 7.297E-2	-3.139E-2 ±i 0.113817
	-7.730E-2 ±i 5.833E-2	-9.367E-2 ±i 9.753E-2
	-5.253E-2 ±i 5.377E-2	-9.320E-2 ±i 9.377E-2
	-3.068E-2 ±i 3.063E-2	-5.464E-2 ±i 5.443E-2
	-3.008E-2 ±i 3.013E-2	-5.336E-2 ±i 5.381E-2
	-2.883E-2 ±i 1.952E-2	-5.357E-2 ±i 5.381E-2
	-1.809E-2 ±i 1.900E-2	-3.071E-2 ±i 3.295E-2
	-1.861E-2 ±i 1.857E-2	-3.314E-2 ±i 3.295E-2
	-1.026E-2 ±i 1.027E-2	-1.823E-2 ±i 1.831E-2
	-6.688E-3 ±i 6.679E-3	-1.190E-2 ±i 1.186E-2
	-6.505E-3 ±i 6.450E-3	-1.157E-2 ±i 1.126E-2

TABLE 3-2 ---CONTINUED

	ρ = 1.0E-7	ρ = 1.0E-8
RESIDUAL MODES	-1.160960 ±i 13.8045 -0.512889 ±i 10.0386 -3.660E-2 ±i 3.96058 -3.375E-2 ±i 3.12973 -4.184E-2 ±i 1.55533 -2.460E-2 ±i 0.707277 -1.376E-2 ±i 0.162513	-1.055620 ±i 13.8246 -0.424581 ±i 9.99995 -0.103651 ±i 3.89098 -7.243E-3 ±i 3.09791 -0.995449 ±i 1.57775 -4.021E-2 ±i 0.698938 -0.179108 ±i 0.16990
CONTROLLED MODES (including compensator)	-0.472570 ±i 1.018910 -0.503537 ±i 0.870568 -0.420918 ±i 0.589258 -6.373E-2 ±i 0.606179 -0.519329 ±i 0.408814 -0.425919 ±i 0.489440 -0.361714 ±i 0.282289 -0.114861 ±i 0.301370 -0.178054 ±i 0.250389 -0.199333 ±i 0.235056 -0.172496 ±i 0.178009 -2.935E-2 ±i 0.199799 -2.757E-2 ±i 0.133152 -9.811E-2 ±i 9.674E-2 -9.822E-2 ±i 9.759E-2 -5.666E-2 ±i 8.175E-2 -8.737E-2 -5.751E-2 ±i 5.287E-2 -5.859E-2 ±i 6.136E-2 -6.537E-2 -3.223E-2 ±i 3.282E-2 -2.124E-2 ±i 2.098E-2 -2.056E-2 ±i 1.927E-2	-1.450610 ±i 1.962800 -1.159140 ±i 1.747550 -1.609500 0.437787 ±i 1.187690 * -0.960471 ±i 0.263277 -0.740885 ±i 0.638645 -5.963E-2 ±i 0.628967 -0.373359 ±i 0.456378 -0.268863 ±i 0.295705 -0.152625 ±i 0.332400 -0.124160 ±i 0.346497 -0.265748 -0.179828 ±i 0.173361 -1.593E-2 ±i 0.203438 -0.143296 ±i 0.112392 -1.001E-2 ±i 0.164318 -1.396E-2 ±i 0.140567 -0.108839 ±i 0.106621 -4.795E-2 ±i 8.326E-2 -7.045E-2 ±i 1.531E-2 -5.587E-2 ±i 5.793E-2 -3.908E-2 ±i 3.706E-3 -3.582E-2 ±i 3.079E-2

* UNSTABLE MODES

4.0 DEMONSTRATION OF A ROBUST TRACKING COMPENSATOR DESIGN

In the same spirit as Ref. [7], we shall now consider the problem of tracking non-zero set point in the presence of unknown constant disturbances. The approach to the variable case is similar and is well documented in the literature (see, e.g., Ref. [6]).

It will be shown that the tracking compensator has the architecture of the estimator-feedback compensator augmented by an additional integral-feedback loop (Fig. 4-1). Indeed, as pointed out in Ref. [8], this partitioned configuration also applies to a general class of robust servomechanisms.

To verify the design, we shall make use of the benchmark MSAT model data listed in Ref. [1]. Furthermore, we shall continue to use the search tehnique described in Section 3 to obtain the nominal design.

4.1 PROBLEM FORMULATION

Consider the following evaluation model taken from Ref.[1]:

$$\dot{x}_p = A_p x_p + B_p u + B_d u_d \qquad (4-1)$$
$$y = C_p x_p$$

where

$$x_p = \begin{bmatrix} \eta_r \\ \eta_e \\ \dot{\eta}_r \\ \dot{\eta}_e \end{bmatrix} \in \mathbb{R}^{32} ; \quad u = \begin{bmatrix} g_1 \\ g_2 \\ f_1^* \\ \vdots \\ f_5^* \end{bmatrix} \in \mathbb{R}^7 ; \quad y = \begin{bmatrix} \underline{\theta}_b \\ f^{-1}\underline{\delta} \\ \underline{\alpha} \\ \underline{\beta} \\ \dot{\underline{\theta}}_b \\ \dot{\underline{\beta}} \end{bmatrix} \in \mathbb{R}^{16} ; \quad u_d = \begin{bmatrix} \underline{g}_c \\ \underline{g}_\beta \\ f_1 \\ \vdots \\ f_{10} \end{bmatrix} \in \mathbb{R}^{15} \qquad (4-2)$$

Here the state vector x_p comprises 5 rotational rigid body modes (η_r) and 11 elastic modes (η_e) as well as their rates. The control input vector consists of 2 gimbal torques (g_1, g_2) and 5 linearly independent equivalent thruster forces ($f_1^* \cdots f_5^*$) derived from the original 8 thrusters described in Ref. [5]. The measurable outputs in y include the attitude angles and rates of the bus ($\underline{\theta}_b$, $\dot{\underline{\theta}}_b$), the gimbal angles and rates ($\underline{\beta}$, $\dot{\underline{\beta}}$) and the displacement ($f^{-1}\underline{\delta}$) and orientation ($\underline{\alpha}$) of the dish relative to the bus. The disturbance inputs in u_d are modeled by 3 reaction wheel torques ($\underline{g}_c$) in the bus and 2 gimbal torques ($\underline{g}_\beta$) as well as 10 forces ($f_1 \cdots f_{10}$) distributed on both the bus and the dish. These forces are made up of the original 8 thruster inputs plus the 2 additional thrusters described in Appendix III of Ref. [7].

Suppose the following outputs are to be controlled:

$$\underline{z} = \begin{bmatrix} \underline{\theta}_b \\ \underline{\theta}_p \\ \underline{\beta} \end{bmatrix} \in \mathbb{R}^7 \qquad (4\text{-}3)$$

which comprises the 3 bus attitude angles ($\underline{\theta}_b$), the 2 beam angles ($\underline{\theta}_p$) and the 2 gimbal angles ($\underline{\beta}$). The objective is to force these outputs to track with zero steady state errors a set of references

$$\underline{z}_0 = \begin{bmatrix} \underline{\theta}_{b\,ref} \\ \underline{\theta}_{p\,ref} \\ \underline{\beta}_{ref} \end{bmatrix}$$

From Ref. [9], we note that the beam angles ($\underline{\theta}_p$) are related to the spacecraft variables ($\underline{\theta}_b, f^{-1}\underline{\delta}, \underline{\alpha}, \underline{\beta}$) via the expression:

$$\underline{\theta}_p = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \underline{\theta}_b + P_{r\delta} f^{-1}\underline{\delta} + P_{r\alpha}\underline{\alpha} + P_{r\beta}\underline{\beta} \qquad (4\text{-}4)^*$$

Thus, the output $\underline{z}$ is related to the measurement y by:

$$\underline{z} = Ty = TC_p x_p := D_p x_p \qquad (4\text{-}5)$$

The system matrices for the evaluation model (4-1) and (4-5) as derived from the data of Ref. [1], are listed in Appendix F.

The **robust tracking problem** can now be defined as follows:

Given a design model

$$\begin{aligned} \dot{x}_c &= A_c x_c + B_c u + B_{d_c} u_d \\ y &= C_c x_c \\ \underline{z} &= Ty := D_c x_c \end{aligned} \qquad (4\text{-}6)$$

where $x_c \in \mathbb{R}^N, \; N < 32.$

Find a dynamic compensator of the form

---

*See Ref. [9] for definition of the flexibility coupling matrices.

$$u = u(y,t) \tag{4-7}$$

with the following properties (4-8):

(a) STABILITY - Stabilizes all the modes in the design model (4-6);

(b) STEADY STATE TRACKING - Forces the output (4-3) to track a constant, possibly non-zero, set point with zero steady state errors;

(c) DISTURBANCE REJECTION - Properties (a) and (b) hold despite the presence of constant, but unknown, disturbance input u_d ;

(d) ROBUSTNESS - Properties (a) to (c) hold in the presence of

i) parametric variation in the controller (4-7) or the design model (4-6), and

ii) unmodeled residual dynamics when the controller (4-7) is applied to the evaluation model (4-1).

4.2 DESIGN MODEL SELECTION

Before proceeding any further, an appropriate design model (4-6) must be selected. In the past, a form of open-loop modal cost analysis (Ref. [9]) has provided a reasonable means of ranking the elastic modes according to their contributions toward a quadratic cost function such as

$$\int_0^{\infty} z^T R_1 z \, dt \tag{4-9}$$

where R_1 is a suitably chosen weighting matrix. A similar approach will be adopted here.

We choose to weight the outputs in the cost function (4-9) in inverse proportion to the square of their maximally allowed tracking errors. Thus, we set

$$R_1 = \text{diag}\{w_1 \cdots w_7\} \tag{4-10}$$

where

$$W_1 = |\tilde{\theta}_{b_1}|^{-2} \qquad W_4 = |\tilde{\theta}_{p_1}|^{-2} \qquad W_6 = |\tilde{\beta}_1|^{-2}$$
$$W_2 = |\tilde{\theta}_{b_2}|^{-2} \qquad W_5 = |\tilde{\theta}_{p_2}|^{-2} \qquad W_7 = |\tilde{\beta}_2|^{-2}$$
$$W_3 = |\tilde{\theta}_{b_3}|^{-2}$$

Here, $|\tilde{\cdot}|$ denotes the maximum tracking error for each output.

Table 4-1 lists the modal costs computed from the evaluation model data of Appendix F, and are based on the following bounds on the tracking errors:

$$\left[|\underline{\tilde{\theta}}_b|\right] = \begin{bmatrix} 0.03^\circ \\ 0.03^\circ \\ 0.1^\circ \end{bmatrix} \;;\quad \left[|\underline{\tilde{\theta}}_p|\right] = \begin{bmatrix} 0.01^\circ \\ 0.01^\circ \end{bmatrix} \;;\quad \left[|\underline{\tilde{\beta}}|\right] = \begin{bmatrix} 0.03^\circ \\ 0.03^\circ \end{bmatrix} . \tag{4-11}$$

From this modal ranking, we select the first 4 elastic modes (3,2,1 and 6) together with all 5 rigid body modes to form the design model (4-6). The corresponding system matrices are listed in Appendix G.

4.3 COMPENSATOR DESIGN

The optimal solution to the robust tracking problem with properties (4-8) (a) - (c), i.e., stability, steady state tracking and disturbance rejection, is well known (see, e.g., Ref. [6]). The compensator is of the integral type given by the following equations:

$$\dot{p} = z - z_o \tag{4-12a}$$

$$\dot{\hat{x}}_c = A_c\hat{x}_c + B_c u + K(y - C_c\hat{x}_c) \tag{4-12b}$$

$$u = -F_1\hat{x}_c - F_2 p + u_o \tag{4-12c}$$

where u_o is an arbitrary constant bias which allows the output to track the non-zero set point z_o. The integrals in (4-12a) perform the same role as in the classical single input-single output case in rejecting constant input disturbances. Figure 4-1 depicts the configuration of such a compensator.

In closed-loop, the steady state values of the integrator outputs in (4-12a) are determined by the bias term u_0, the set point z_0 and the disturbance input u_d. However, it can be shown that setting

$$u_0 = H_c^{-1}(0)\, z_0 \qquad (4\text{-}13)$$

will remove their dependence on u_0 and z_0. Here the matrix $H_c(0)$ denotes the zero-frequency gain of the closed-loop transfer function matrix

$$H_c(s) = D_c(sI - A_c - B_c F_1)^{-1} B_c$$

of the design system (4-6).

We may combine the state variables in the compensator (4-12) to form

$$x_1 := \begin{bmatrix} \hat{x}_c \\ p \end{bmatrix}$$

so that Equations (4-12a-c) can be written in the compact form

$$\begin{aligned} \dot{x}_1 &= A_1 x_1 + B_1 y + B_0 z_0 \\ u &= -D_1 x_1 + D_0 z_0 \end{aligned} \qquad (4\text{-}14)$$

where

$$A_1 := \begin{bmatrix} A_c - B_c F_1 - K C_c & -B_c F_2 \\ 0 & 0 \end{bmatrix} \; ; \quad B_1 := \begin{bmatrix} K \\ I \end{bmatrix} \; ; \quad B_0 := \begin{bmatrix} B_c H_c^{-1}(0) \\ -I \end{bmatrix}$$

$$D_1 := \begin{bmatrix} F_1 & F_2 \end{bmatrix} \; ; \qquad D_0 := H_c^{-1}(0) \, .$$

The closed-loop system obtained when the compensator (4-14) is applied to the evaluation model (4-1) and (4-5) is then described by the following equations

$$\begin{bmatrix} \dot{x}_p \\ \dot{x}_1 \end{bmatrix} = \begin{bmatrix} A_p & -B_p D_1 \\ B_1 D_p & A_1 \end{bmatrix} \begin{bmatrix} x_p \\ x_1 \end{bmatrix} + \begin{bmatrix} B_p D_0 \\ B_0 \end{bmatrix} z_0 + \begin{bmatrix} B_d \\ 0 \end{bmatrix} u_d \qquad (4\text{-}15)$$

$$z = \begin{bmatrix} D_p & 0 \end{bmatrix} \begin{bmatrix} x_p \\ x_1 \end{bmatrix} .$$

Note that provided the system matrix in (4-15) is asymptotically stable, it is guaranteed that

$$\begin{bmatrix} \dot{x}_p(t) \\ \dot{p}(t) \end{bmatrix} \to 0 \ , \quad t \to \infty .$$

In other words, by virtue of (4-12a), steady state tracking is achieved. Furthermore, this will occur despite the presence of the constant disturbance input u_d and for any setting of the bias term u_o . Hence, we see that both properties (4-8b) and (4-8c) automatically hold when the closed-loop evaluation system (4-15) is asymptotically stable. The robustness property (4-8d) will be shown at a later stage.

It can be shown that necessary and sufficient conditions for the existence of the control law (4-12c) are that

(a) the design model (4-6) has no unstable fixed modes, i.e., it must be stabilizable, and

(b) the open-loop transfer function matrix of (4-6)

$$H(s) = D_c (sI - A_c)^{-1} B_c$$

contains no transmission zeros at the origin.

In the case of non-constant set point or disturbance, condition (b) is modified to read "no transmission zeros at the frequencies of the tracking signal or disturbance".

The control law parameters in (4-12c) may be determined by minimizing a cost function of the form

$$J = \int_0^\infty \left(z^T R_1 z + p^T R_1' p + \rho\, u^T R_2 u \right) dt , \qquad (4\text{-}16)$$

where R_1 , R_1' and R_2 are suitably chosen weighting matrices; ρ is a positive scalar constant which will be used later on as a search parameter during design iteration.

The first and the last terms in (4-16) are the standard output and input penalty functions in optimal control. Indeed, the output weighting matrix could be taken directly from the cost function (4-9) used in the modal cost analysis for the design model. The second term in (4-16) regulates the transient responses at the outputs of the feedback integrators. The control law (4-12c) is obtained from the steady state solution of an algebraic matrix Riccati equation for which several options are available in KEDDC.

As stated in (4-12b), the estimator may be either a Kalman filter or a Luenberger observer. For the Kalman filter design, we need to recast the design model (4-6) in the form

$$\begin{aligned} \dot{x}_c &= A_c x_c + B_c u + B_{d_c} w_d \\ y &= C_c x_c + w_m , \end{aligned} \tag{4-17}$$

where w_d and w_m represent random input disturbance and measurement noise, respectively. These may be assumed to be uncorrelated zero-mean white noise processes with intensities of

$$\begin{bmatrix} w_d \\ w_m \end{bmatrix} \sim \begin{bmatrix} V_1 & 0 \\ 0 & \rho V_2 \end{bmatrix} . \tag{4-18}$$

The scalar constant ρ here will be used later on to vary the estimator parameters during design iteration. For any given set of intensities, the estimator parameters are determined by the steady state solution of an algebraic matrix Riccati equation.

4.4 ROBUSTNESS PROPERTIES

Before proceeding with the design, it is perhaps worthwhile to show that the compensator proposed in (4-12) indeed possesses some of the robustness properties of (4-8d). Specifically, we shall demonstrate robustness vis-à-vis parametric uncertainties (4-8d-i); the spillover robustness property (4-8d-ii) is much more difficult to show analytically, and will be numerically verified at the design stage.

Suppose the actual model for the design system is given by

$$\begin{aligned} \dot{x}_c &= (A_c + \Delta A_c) x_c + (B_c + \Delta B_c) u + v_d \\ y &= (C_c + \Delta C_c) x_c \\ z &= T y := (D_c + \Delta D_c) x_c , \end{aligned} \tag{4-19}$$

where $\Delta(\cdot)$ denotes the perturbation in the parameters about their nominal values. The disturbance input terms have been grouped into the single vector $\tilde{v}_d$.

By defining the state estimation error as $\tilde{x}_c := x_c - \hat{x}_c$,

we can write the error dynamic equation from (4-12b) and (4-19) as

$$\dot{\tilde{x}}_c = (A_c - KC_c)\tilde{x}_c + (\Delta A_c - K\Delta C_c)x_c + \Delta B_c u + \tilde{v}_d .$$

Similarly, the control law (4-12c) becomes

$$u = -F_1 x_c - F_2 p + F_1 \tilde{x}_c + H_c^{-1}(0)\, z_0 .$$

The closed-loop system when the compensator (4-12) is applied to the perturbed design model (4-19) is then given by

$$\begin{bmatrix} \dot{x}_c \\ \dot{p} \\ \dot{\tilde{x}}_c \end{bmatrix} = \begin{bmatrix} A_c - B_cF_1 + (\Delta A_c - \Delta B_cF_1) & -(B_c+\Delta B_c)F_2 & (B_c+\Delta B_c)F_1 \\ C_c + \Delta C_c & 0 & 0 \\ \Delta A_c - K\Delta C_c - \Delta B_cF_1 & -\Delta B_cF_2 & A_c - KD_c + \Delta B_cF_1 \end{bmatrix} \begin{bmatrix} x_c \\ p \\ \tilde{x}_c \end{bmatrix} \qquad (4\text{-}20)$$

$$+ \begin{bmatrix} (B_c+\Delta B_c) \\ -H_c(0) \\ \Delta B_c \end{bmatrix} H_c^{-1}(0)\, z_0 + \begin{bmatrix} I \\ 0 \\ I \end{bmatrix} \tilde{v}_d$$

$$z = \begin{bmatrix} D_c + \Delta D_c & 0 & 0 \end{bmatrix} \begin{bmatrix} x_c \\ p \\ \tilde{x}_c \end{bmatrix} .$$

Clearly, provided the system matrix in (4-20) is asymptotically stable, we still get

$$(\dot{x}_c(t), \dot{p}(t), \dot{\tilde{x}}_c(t)) \rightarrow 0 \quad , \; t \rightarrow \infty ;$$

i.e., steady state tracking is maintained despite the presence of the constant disturbance term $\tilde{v}_d$ and parametric variations in the design model (4-6).

It is well known that stability is a **generic** property (Ref. [10]): wherever a matrix is asymptotically stable for a given set of parameters, it will remain asymptotically stable for all variations of the parameters within a certain neighbourhood of their nominal values. Therefore, we conclude that sufficiently "small" perturbation in the parameters of the design model about their nominal values will not destabilize the closed-loop system matrix of (4-20). This proves the robustness property (4-8d-i). How "small" these variations must be before instability sets in, however, remains to be determined; this we shall do numerically in a later section.

4.5 DESIGN RESULTS

In order to obtain a nominal compensator design which will stabilize all the modes in the evaluation model, we adopt the same search technique used earlier in the regulator design problem. Its robustness properties will be demonstrated with sensitivity analysis in the next section.

Table 4-2 lists the design values adopted for the weighting matrices in the cost function (4-16) and the white noise intensities of (4-18). In the absence of any guideline, we set the integrator output weighting factors (R_1') to be of the same order of magnitude as the output weighting factors (R_1).

The intensity values (V_1 and V_2) are derived from a standard wide-bandwidth coloured noise assumption: when the bandwidth of a noise process is sufficiently large compared to the bandwidth of the system to which it is applied, the noise may be considered to be effectively white with intensity approximated by the power spectral density of the coloured noise at low frequencies.

In the case of w_d , we have assumed an rms value of 2.5 N-m for each disturbance torque and 2.5 N (rms) for each disturbance force; the power spectral densities are taken to be constant over $\pm$50 Hz and zero outside of this range. For the measurement noise w_m , we have assumed 0.001 deg (rms) for all angular measurements and 0.0001 deg/s (rms) for all rate measurements. Here the power spectral densities are assumed to be constant over $\pm$100 Hz and zero elsewhere.

The open-loop eigenvalues for the design and evaluation models are listed in Table 4-3. Table 4-4 lists the closed-loop evaluation system eigenvalues for values of ρ ranging from 100 to 1.0E5. It appears that stability (i.e., Property (4-8a)) is achieved for values of ρ above 1.0E3. Below this value, the spillover from the unmodeled modes becomes excessive and eventually destabilizes the system. The compensator parameter for the nominal case (ρ = 1.0E3) are listed in Appendix H.

The steady state output response of the closed-loop system (4-15) is given by

$$z = \begin{bmatrix} D_p & 0 \end{bmatrix} \begin{bmatrix} -A_p & B_p D_1 \\ -B_1 D_p & -A_1 \end{bmatrix}^{-1} \left\{ \begin{bmatrix} B_p D_o \\ B_o \end{bmatrix} z_o + \begin{bmatrix} B_d \\ 0 \end{bmatrix} u_d \right\}$$

which may be rewritten as

$$z = H_o z_o + H_d u_d . \tag{4-21}$$

Tracking with zero steady state error occurs only when the output response matrices H_o and H_d are the identity and zero matrices, respectively. These matrices are listed in Table 4-5 for the nominal design. It is clear that both steady state tracking and disturbance rejection (i.e., properties (4-8b,c)) have been achieved. Furthermore, since these properties hold in the presence of all the residual modes in the evaluation model, we have also demonstrated (4-8d-ii) for the nominal compensator.

4.6 DEMONSTRATION OF ROBUSTNESS

We shall now demonstrate the robustness of the nominal compensator (Appendix H) to parametric uncertainties in the controller and the design model (i.e., (4-8d-i)). For this, as pointed out in Section 4.4, it is only necessary to demonstrate stability of the closed-loop evaluation system (4-15) in the presence of parametric perturbation.

A common source of errors in the controller is due to round-offs in the controller gains during implementation. To demonstrate robustness in this regard, the controller gains F_1 , F_2 and $H_c^{-1}(0)$ of (4-12c) are rounded off to various degrees of accuracy; the case of 1 significant figure accuracy is listed in Table 4-6.

Errors in the design model parameters could seriously affect the performance of the estimator (4-12b) since the latter typically embodies a copy of the nominal design model in its internal structure. To demonstrate sensitivity in this regard, we multiply all the paramaters of the nominal estimator (Appendix H) by a constant factor representing variations of 1 to 20 percent from their nominal values.

The compensator with the modified controller gains and estimator parameters is then applied to the evaluation model (4-1). Table 4-7 lists the number of unstable closed-loop eigenvalues that result. It appears that the closed-loop evaluation system is relatively insensitive to round-off errors in the controller gains. This is further demonstrated in Table 4-8 which lists the closed-loop eigenvalues with various degrees of numerical accuracy in the controller gains.

The closed-loop system stability is relatively more sensitive to parametric perturbation in the estimator however. This is demonstrated by the eigenvalues listed in Table 4-9. Nevertheless, for variations below 5 percent, the closed-loop eigenvalues remain quite acceptable.

Hence, we conclude that the nominal compensator of Appendix H is highly robust with regard to the numerical accuracy of the controller gains and moderately robust in the presence of variations in the estimator parameters.

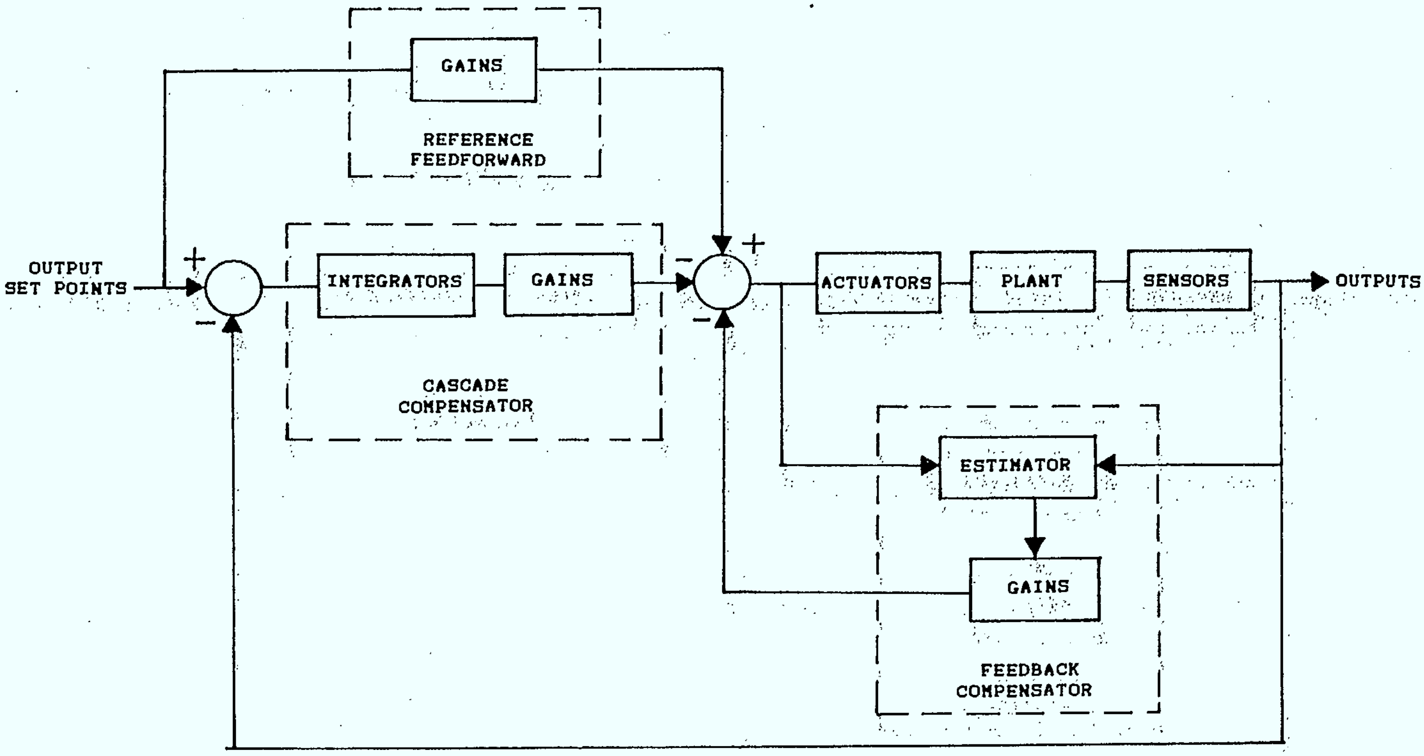

FIGURE 4-1 Partitioned Configuration of Tracking Compensator

TABLE 4-1 Modal Costs of Benchmark Model

MODE NO.	FREQUENCY (RAD/SEC)	MODAL COSTS
3	0.239522	0.205407E+2
2	0.151178	0.129580E+1
1	0.124348	0.487066E 0
6	0.779434	0.211837E 0
9	1.551440	0.183379E 0
11	13.804100	0.154724E 0
4	0.556322	0.135429E 0
10	10.046000	0.131883E 0
5	0.690179	0.657074E-2
7	1.022720	0.402586E-2
8	1.087340	0.117715E-2

TABLE 4-2 Design Values of Quadratic Cost Weighting Matrices and Noise Intensities for the Tracking Problem

Matrix $\begin{bmatrix} D_c^T R_1 D_c & 0 \\ 0 & R_1' \end{bmatrix}$:

MATRIX A FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 9
DIMENSION 25*25, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	30.1656	-1.280065E-02	-3.070631E-02	-3.043099E-03	420.766
(2)	-1.280065E-02	39.9849	27.9971	-458.283	-.178804
(3)	-3.070631E-02	27.9971	20.9204	-320.791	-.428339
(4)	-3.043099E-03	-458.283	-320.791	6023.90	-3.198634E-02
(5)	420.766	-.178804	-.428339	-3.198634E-02	6700.75
(6)	5.474248E-03	6.51054	5.31940	-125.773	7.163733E-02
(7)	-3.04528	-5.400979E-02	-4.558394E-02	1.03325	-45.8044
(8)	-15.0565	1.939919E-02	2.825752E-02	-.191570	-247.471
(9)	-3.448858E-02	-16.4633	-11.3469	41.6997	-.373792
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	5.474248E-03	-3.04528	-15.0565	-3.448858E-02	0.00000
(2)	6.51054	-5.400979E-02	1.939919E-02	-16.4633	0.00000
(3)	5.31940	-4.558394E-02	2.825752E-02	-11.3469	0.00000
(4)	-125.773	1.03325	-.191570	41.6997	0.00000
(5)	7.163733E-02	-45.8044	-247.471	-.373792	0.00000
(6)	4.94117	-3.607387E-02	2.784558E-02	4.43782	0.00000
(7)	-3.607387E-02	2.31682	8.54658	1.085328E-02	0.00000
(8)	2.784558E-02	8.54658	32.8982	1.864031E-02	0.00000
(9)	4.43782	1.085328E-02	1.864031E-02	214.197	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE 4-2 --- CONTINUED

Matrix $\begin{bmatrix} D_c^T R_1 D_c & 0 \\ 0 & R_1' \end{bmatrix}$ (cont'd.) :

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	3.647600E+06	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	3.647600E+06
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE 4-2 --- CONTINUED

	(21)	(22)	(23)	(24)	(25)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	328280.	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	3.282800E+07	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	3.282800E+07	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	3.647600E+06	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	3.647600E+06

Matrix R_2 :

MATRIX B FROM FILE DZMD , BLOCKNO. 5, MATRIXNO.10
DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	1.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	1.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	1.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	1.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	1.00000	0.00000
(7)	0.00000	1.00000

TABLE 4-2 --- CONTINUED

Matrix $B_{d_c} V_1 B_{d_c}^T$:

MATRIX C FROM FILE DZMD , BLOCKNO. 5, MATRIXNO.11
DIMENSION 18X18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	1.862745E-04
(11)	0.00000	0.00000	0.00000	0.00000	-5.467824E-08
(12)	0.00000	0.00000	0.00000	0.00000	-8.304348E-08
(13)	0.00000	0.00000	0.00000	0.00000	-1.043717E-08
(14)	0.00000	0.00000	0.00000	0.00000	-7.223856E-06
(15)	0.00000	0.00000	0.00000	0.00000	3.740563E-07
(16)	0.00000	0.00000	0.00000	0.00000	5.268962E-05
(17)	0.00000	0.00000	0.00000	0.00000	-6.015231E-05
(18)	0.00000	0.00000	0.00000	0.00000	1.117428E-08

TABLE 4-2 --- CONTINUED

Matrix $B_{\alpha_c} V_1 B_{\alpha_c}^T$ (cont'd.) :

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	-5.467824E-08	-8.304348E-08	-1.043717E-08	-7.223856E-06	3.740563E-07
(11)	7.329006E-05	-3.309283E-05	1.493306E-06	5.995790E-10	3.921998E-05
(12)	-3.309283E-05	3.207849E-05	7.932499E-07	8.769021E-09	-9.574449E-06
(13)	1.493306E-06	7.932499E-07	3.538659E-06	7.825178E-10	1.077610E-06
(14)	5.995790E-10	8.769021E-09	7.825178E-10	3.690944E-06	-1.393118E-08
(15)	3.921998E-05	-9.574449E-06	1.077610E-06	-1.393118E-08	2.610604E-05
(16)	-2.318679E-07	-3.547880E-08	-1.214812E-08	-2.445818E-06	-6.545907E-08
(17)	4.387018E-08	6.033546E-08	7.097497E-09	7.057460E-07	-7.822477E-08
(18)	1.574592E-05	-7.363499E-06	2.448564E-06	-1.768782E-09	1.018323E-05

	(16)	(17)	(18)
(1)	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000
(10)	5.268962E-05	-6.015231E-05	1.117428E-08
(11)	-2.318679E-07	4.387018E-08	1.574592E-05
(12)	-3.547880E-08	6.033546E-08	-7.363499E-06
(13)	-1.214812E-08	7.097497E-09	2.448564E-06
(14)	-2.445818E-06	7.057460E-07	-1.768782E-09
(15)	-6.545907E-08	-7.822477E-08	1.018323E-05
(16)	2.034335E-05	8.019212E-06	-4.641651E-08
(17)	8.019212E-06	1.604670E-04	1.553975E-08
(18)	-4.641651E-08	1.553975E-08	9.363654E-06

TABLE 4-2 --- CONTINUED

Matrix V_2 :

MATRIX A FROM FILE DZMD , BLOCKNO. 5, MATRIXNO.12
DIMENSION 16X16, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.523087E-12	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	1.523087E-12	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	1.523087E-12	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	1.523087E-12	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	1.523087E-12
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	1.523087E-12	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	1.523087E-12	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	1.523087E-12	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	1.523087E-12	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	1.523087E-12
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(11)	(12)	(13)	(14)	(15)	(16)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	1.523087E-12	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	1.523087E-14	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	1.523087E-14	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	1.523087E-14	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	1.523087E-14	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000	1.523087E-14

TABLE 4-3 Open-loop Eigenvalues for the Tracking Problem

	EVALUATION MODEL		DESIGN MODEL
RIGID BODY MODES	Ø.Ø (repeated 1Ø times)		Ø.Ø (repeated 1Ø times)
ELASTIC BODY MODES	-2.1Ø8E-2 ±i Ø.779345 -1.7Ø5E-3 ±i Ø.239518 -9.23ØE-4 ±i Ø.124347 -8.53ØE-4 ±i Ø.151178	CONTROLLED	-2.1Ø8E-2 ±i Ø.779345 -1.7Ø5E-3 ±i Ø.239518 -9.23ØE-4 ±i Ø.124347 -8.53ØE-4 ±i Ø.151178
	-1.1746Ø ±i 13.8Ø41 -Ø.5239Ø4 ±i 1Ø.Ø46Ø -7.5Ø5E-2 ±i 1.55144 -6.Ø64E-3 ±i 1.Ø8734 -8.Ø59E-3 ±i 1.Ø2272 -5.531E-3 ±i Ø.69Ø179 -8.557E-3 ±i Ø.556322	RESIDUAL	

TABLE 4-4 Closed-loop Evaluation System Eigenvalues for the Tracking Problem

	ρ = 1.0E+5	ρ = 1.0E+4
RESIDUAL MODES	−1.253860 ±i 14.11590	−1.492790 ±i 15.50530
	−0.447271 ±i 10.19800	−0.259323 ±i 10.59820
	−7.506E−2 ±i 1.549120	−7.238E−2 ±i 1.539380
	−6.063E−3 ±i 1.087410	−6.038E−3 ±i 1.087740
	−7.944E−3 ±i 1.024130	−9.672E−3 ±i 1.029160
	−5.409E−3 ±i 0.692430	−9.736E−3 ±i 0.711640
	−5.829E−3 ±i 0.566992	−8.248E−3 ±i 0.611663
CONTROLLED MODES (including compensator)	−2.111E−2 ±i 0.779420	−8.793E−2 ±i 0.777104
	−3.653E−2 ±i 0.778697	−2.104E−2 ±i 0.779398
	−4.565E−3 ±i 0.239586	−1.322E−2 ±i 0.240226
	−5.488E−2 ±i 0.235902	−0.170520 ±i 0.193135
	−1.333E−3 ±i 0.151112	−8.783E−2 ±i 0.158532
	−6.724E−3 ±i 0.152010	−3.014E−3 ±i 0.150567
	−3.599E−3 ±i 0.124508	−1.036E−2 ±i 0.155176
	−2.139E−2 ±i 0.126577	−5.199E−2 ±i 0.154047
	−6.111E−2 ±i 0.106194	−7.603E−3 ±i 0.126664
	−0.122220	−4.701E−2 ±i 0.131843
	−0.132219	−0.179065
	−5.107E−2 ±i 9.849E−2	−0.173113
	−3.247E−2 ±i 5.492E−2	−4.821E−2 ±i 7.945E−2
	−1.732E−2 ±i 3.869E−2	−2.092E−2 ±i 5.694E−2
	−3.114E−2 ±i 4.409E−2	−4.908E−4
	−4.702E−2 ±i 3.915E−2	−4.873E−4
	−6.276E−2	−0.121506
	−5.536E−2 ±i 8.178E−3	−9.677E−2 ±i 5.035E−2
	−3.918E−2 ±i 3.513E−2	−4.079E−2 ±i 5.070E−2
	−4.560E−2 ±i 3.473E−2	−7.761E−2 ±i 5.580E−2
	−3.203E−2 ±i 2.864E−2	−6.546E−2 ±i 5.755E−2
	−3.704E−2 ±i 2.295E−2	−8.239E−2 ±i 4.357E−2
	−1.560E−4 ±i 1.215E−6	−9.143E−2
		−8.606E−2
		−5.361E−2 ±i 1.909E−2

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TABLE 4-4 ---CONTINUED

	ρ = 1.0E+3	ρ = 1.0E+2
RESIDUAL MODES	-1.885260 ±i 20.80360	-2.626500 ±i 34.80960
	-0.106470 ±i 11.05890	-7.553E-2 ±i 11.26330
	-4.749E-2 ±i 1.501200	0.147065 ±i 1.399210 *
	-6.772E-3 ±i 1.093150	-1.087E-2 ±i 1.079630
	-2.407E-2 ±i 1.039420	-3.742E-2 ±i 1.003100
	-2.201E-2 ±i 0.779488	-2.464E-2 ±i 0.779871
	-7.747E-3 ±i 0.656300	-5.885E-3 ±i 0.662209
CONTROLLED MODES (including compensator)	-0.948199	-3.128380
	-8.721E-2 ±i 0.887757	-1.502090
	-0.232469 ±i 0.798301	-0.408867 ±i 1.474480
	-0.364507	-0.687241 ±i 0.926420
	-0.122789 ±i 0.231737	-0.429995
	-3.498E-2 ±i 0.243471	-0.166849 ±i 0.343024
	-0.271089	1.074E-2 ±i 0.313069 *
	-2.868E-2 ±i 0.233024	-0.260080 ±i 0.197197
	-0.150244 ±i 0.133151	-0.206246 ±i 0.244639
	-0.158051 ±i 0.131145	-7.424E-2 ±i 0.262900
	-9.297E-3 ±i 0.157208	-0.262054 ±i 7.925E-2
	-5.772E-3 ±i 0.148253	-9.674E-2 ±i 0.143424
	-1.294E-2 ±i 0.136720	-5.771E-2 ±i 0.172578
	-5.729E-2 ±i 0.140760	-6.671E-3 ±i 0.146587
	-7.193E-2 ±i 0.111687	-1.262E-2 ±i 0.156744
	-0.175142 ±i 4.864E-2	-1.093E-2 ±i 0.155965
	-2.632E-2 ±i 7.778E-2	-0.203952
	-5.641E-2 ±i 6.923E-2	-3.209E-2 ±i 0.111407
	-1.564E-3	-8.989E-2 ±i 9.457E-2
	-1.451E-3	-4.991E-3
	-0.135853	-4.351E-3
	-7.340E-2 ±i 2.046E-2	-0.105388 ±i 2.777E-2
	-0.126331	-0.127057
	-0.103870	-0.100630
	-0.107568	-0.100363
	-0.109545	-0.102554
	-0.106783	-0.100443

* UNSTABLE MODES

TABLE 4-5 Steady State Output Matrices for the Nominal Tracking Compensator Design

Matrix H_θ :

DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.00000	7.222570E-19	-5.757741E-20	-3.578825E-17	-7.157720E-19
(2)	1.069804E-18	1.00000	1.400211E-17	-1.317013E-19	-1.268188E-16
(3)	2.371769E-20	3.276686E-16	1.00000	3.413336E-18	-3.091838E-16
(4)	1.154978E-16	4.049099E-18	-2.575951E-20	1.00000	-4.052902E-18
(5)	7.680477E-18	5.005569E-16	1.212298E-17	-6.181762E-18	1.00000
(6)	2.599146E-18	-1.163049E-16	1.816813E-18	-2.076652E-18	1.206527E-16
(7)	2.163441E-17	-2.449042E-18	-6.235565E-20	-3.069375E-17	2.369140E-18

	(6)	(7)
(1)	-1.622449E-18	1.058575E-16
(2)	-2.362052E-16	2.233253E-18
(3)	-5.877398E-16	-3.703425E-18
(4)	-7.707981E-18	2.070804E-16
(5)	-9.372822E-16	1.478602E-17
(6)	1.00000	4.714397E-18
(7)	4.271041E-18	1.00000

Matrix H_d :

DIMENSION 7*15, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.169683E-20	-3.883165E-23	-3.626728E-23	2.788458E-23	-1.114277E-20
(2)	1.320579E-22	1.602558E-21	6.031915E-21	1.108203E-20	2.405997E-22
(3)	1.899441E-22	3.168762E-20	2.222166E-20	6.067498E-20	-1.409834E-21
(4)	2.638283E-20	-2.287513E-22	-2.990618E-23	1.893476E-23	-7.052080E-20
(5)	-2.514008E-22	-3.294254E-20	8.046255E-21	1.698339E-20	8.705608E-23
(6)	-8.291879E-24	-3.360910E-21	1.198693E-21	-3.733751E-20	3.227276E-23
(7)	6.397284E-21	1.487525E-23	-2.423700E-23	-8.513024E-23	-6.604930E-20

	(6)	(7)	(8)	(9)	(10)
(1)	5.014197E-21	-5.107028E-21	-5.337026E-21	5.429769E-21	-3.025617E-21
(2)	3.482587E-20	-1.770260E-20	1.745073E-20	-3.454548E-20	4.921173E-20
(3)	1.801071E-19	-1.369088E-20	1.249203E-20	-1.788130E-19	-3.310288E-20
(4)	1.694106E-20	-1.708590E-20	-1.721897E-20	1.736393E-20	-1.388282E-20
(5)	5.572719E-20	-1.436558E-20	1.410157E-20	-5.538003E-20	3.534339E-20
(6)	4.309276E-21	-6.091781E-21	6.105650E-21	-4.306472E-21	3.808347E-20
(7)	7.009995E-21	-7.270317E-21	-7.224937E-21	7.485009E-21	3.026564E-21

	(11)	(12)	(13)	(14)	(15)
(1)	2.715858E-21	3.025617E-21	-2.715858E-21	9.230170E-20	6.929102E-19
(2)	5.104229E-20	-4.921173E-20	-5.104229E-20	3.841682E-22	2.043055E-21
(3)	-2.553560E-20	3.310288E-20	2.553560E-20	1.077350E-21	3.755733E-21
(4)	1.384672E-20	1.388282E-20	-1.384672E-20	2.077638E-19	1.540848E-18
(5)	3.770875E-20	-3.534339E-20	-3.770875E-20	-6.949205E-21	-4.858054E-20
(6)	3.798916E-20	-3.808347E-20	-3.798916E-20	-9.575699E-22	-6.864325E-21
(7)	-3.232704E-21	-3.026564E-21	3.232704E-21	5.069501E-20	3.792845E-19

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TABLE 4-6 Nominal Controller Feedback Gains Rounded to One Significant Figure Accuracy

Matrix F_1 :

MATRIX A FROM FILE DZMD5 , BLOCKNO. 7, MATRIXNO. 1
DIMENSION 7*18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	3.000000E-05	-1.00000	-1.00000	20.0000	-1.000000E-04
(2)	1.00000	-8.000000E-04	-2.000000E-03	-3.000000E-04	20.0000
(3)	5.000000E-05	.800000	.600000	2.00000	2.000000E-04
(4)	-.200000	2.000000E-03	3.000000E-03	5.000000E-04	3.00000
(5)	5.000000E-04	.600000	1.00000	.300000	2.000000E-03
(6)	-.800000	-.900000	-.300000	2.00000	2.00000
(7)	.800000	-.900000	-.300000	2.00000	2.00000

	(6)	(7)	(8)	(9)	(10)
(1)	-.300000	2.000000E-03	-3.000000E-04	2.000000E-02	-1.000000E-03
(2)	-1.000000E-04	-.100000	-.200000	-4.000000E-05	3.00000
(3)	-7.000000E-02	-4.000000E-04	-8.000000E-05	-4.000000E-02	1.000000E-02
(4)	-8.000000E-05	-8.000000E-02	.200000	3.000000E-04	-.700000
(5)	8.000000E-02	-3.000000E-03	1.000000E-03	9.000000E-03	-3.000000E-03
(6)	-.100000	-.200000	.500000	-7.000000E-03	-6.00000
(7)	-.100000	.200000	-.500000	-7.000000E-03	6.00000

	(11)	(12)	(13)	(14)	(15)
(1)	-4.00000	-4.00000	70.0000	-2.000000E-03	-2.00000
(2)	-6.000000E-03	-1.000000E-02	1.000000E-04	70.0000	3.000000E-04
(3)	8.00000	6.00000	7.00000	4.000000E-03	-4.00000
(4)	2.000000E-02	3.000000E-02	-5.000000E-03	10.0000	7.000000E-03
(5)	6.00000	11.0000	6.000000E-02	-1.000000E-02	-.600000
(6)	-9.00000	-2.00000	7.00000	-6.00000	3.00000
(7)	-9.00000	-2.00000	7.00000	6.00000	3.00000

	(16)	(17)	(18)
(1)	1.000000E-02	-5.000000E-03	.200000
(2)	-1.00000	-2.00000	-1.000000E-03
(3)	4.000000E-02	1.000000E-02	-.800000
(4)	2.00000	2.00000	6.000000E-03
(5)	-2.000000E-02	-2.000000E-02	.200000
(6)	-.600000	-.400000	-.200000
(7)	.500000	.500000	-.200000

TABLE 4-6 --- CONTINUED

Matrix F_2 :

MATRIX B FROM FILE DZMD5 , BLOCKNO. 7, MATRIXNO. 2
DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	3.000000E-02	-2.00000	-2.00000	-3.000000E-02	-200.000
(2)	-4.00000	3.000000E-02	-8.000000E-03	200.000	-4.000000E-02
(3)	-.200000	60.0000	.400000	.200000	-30.0000
(4)	-40.0000	-.200000	4.000000E-02	40.0000	.200000
(5)	.200000	10.0000	20.0000	-.100000	10.0000
(6)	-30.0000	-10.0000	7.00000	-40.0000	-40.0000
(7)	30.0000	-10.0000	7.00000	40.0000	-40.0000

	(6)	(7)
(1)	20.0000	6.000000E-02
(2)	-8.000000E-02	20.0000
(3)	-20.0000	-.300000
(4)	.500000	-40.0000
(5)	30.0000	.300000
(6)	-30.0000	30.0000
(7)	-30.0000	-30.0000

Matrix $H_c^{-1}(0)$:

MATRIX C FROM FILE DZMD5 , BLOCKNO. 7, MATRIXNO. 3
DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	7.00000	-2000.00	-50.0000	-7.00000	300.000
(2)	4000.00	40.0000	-.200000	-3000.00	-40.0000
(3)	-30.0000	9000.00	20.0000	30.0000	-8000.00
(4)	-20000.0	-200.000	1.00000	20000.0	200.000
(5)	90.0000	-4000.00	300.000	-90.0000	4000.00
(6)	4000.00	4000.00	200.000	-5000.00	-5000.00
(7)	-4000.00	4000.00	200.000	5000.00	-5000.00

	(6)	(7)
(1)	3000.00	10.0000
(2)	-70.0000	8000.00
(3)	-20000.0	-70.0000
(4)	400.000	-50000.0
(5)	8000.00	200.000
(6)	-9000.00	10000.0
(7)	-8000.00	-10000.0

TABLE 4-7 Number of Unstable Closed-loop Evaluation System Eigenvalues due to Round-off Errors and Parameter Perturbation

		NUMBER OF SIGNIFICANT FIGURES RETAINED IN CONTROLLER GAINS				
		NOMINAL	5	3	2	1
PERCENTAGE CHANGE IN ESTIMATOR PARAMETERS	NOMINAL	0	0	0	0	0
	1	0	0	0	0	0
	5	0	0	0	0	0
	10	2	2	2	2	2
	20	4	4	4	4	4

TABLE 4-8 Sensitivity of Closed-loop Evaluation System Eigenvalues to Round-off Errors in Controller Gains Alone

	NUMBER OF SIGNIFICANT FIGURES RETAINED		
	NOMINAL	3	1
RESIDUAL MODES	-1.885260 ±i 20.80360	-1.885450 ±i 20.81200	-1.872580 ±i 20.79460
	-0.106470 ±i 11.05890	-0.106382 ±i 11.05920	-0.105653 ±i 11.05810
	-4.749E-2 ±i 1.501200	-4.744E-2 ±i 1.501170	-4.707E-2 ±i 1.497490
	-6.772E-3 ±i 1.093150	-6.803E-3 ±i 1.093170	-6.360E-3 ±i 1.093650
	-2.407E-2 ±i 1.039420	-2.410E-2 ±i 1.039430	-2.384E-2 ±i 1.040030
	-2.201E-2 ±i 0.779488	-2.201E-2 ±i 0.779488	-2.225E-2 ±i 0.779412
	-7.747E-3 ±i 0.656300	-7.748E-3 ±i 0.656328	-7.662E-3 ±i 0.656428
CONTROLLED MODES (including compensator)	-0.948199	-0.948211	-0.946249
	-8.721E-2 ±i 0.887757	-8.771E-2 ±i 0.888301	-8.705E-2 ±i 0.888665
	-0.232469 ±i 0.798301	-0.232435 ±i 0.798415	-0.238130 ±i 0.794513
	-0.364507	-0.364870	-0.367380
	-0.122789 ±i 0.231737	-0.122244 ±i 0.231893	-0.115397 ±i 0.255193
	-3.498E-2 ±i 0.243471	-3.494E-2 ±i 0.243445	-5.007E-2 ±i 0.243303
	-0.271089	-0.271833	-0.290839
	-2.868E-2 ±i 0.233024	-2.867E-2 ±i 0.233197	-1.815E-2 ±i 0.240148
	-0.150244 ±i 0.133151	-0.150224 ±i 0.133152	-0.175518 ±i 0.142941
	-0.158051 ±i 0.131145	-0.157931 ±i 0.132145	-0.145501 ±i 0.131732
	-9.297E-3 ±i 0.157208	-9.296E-3 ±i 0.157206	-7.016E-2 ±i 0.165551
	-5.772E-3 ±i 0.148253	-5.782E-3 ±i 0.148257	-9.177E-3 ±i 0.157090
	-1.294E-2 ±i 0.136720	-1.298E-2 ±i 0.136721	-1.322E-2 ±i 0.136203
	-5.729E-2 ±i 0.140760	-5.717E-2 ±i 0.140782	-6.359E-3 ±i 0.147016
	-7.193E-2 ±i 0.111687	-7.194E-2 ±i 0.111535	-5.946E-2 ±i 0.144489
	-0.175142 ±i 4.864E-2	-0.175299 ±i 4.815E-2	-0.185877 ±i 3.656E-2
	-2.632E-2 ±i 7.778E-2	-2.623E-2 ±i 7.768E-2	-2.321E-2 ±i 7.609E-2
	-5.641E-2 ±i 6.923E-2	-5.626E-2 ±i 6.882E-2	-4.981E-2 ±i 7.113E-2
	-1.564E-3	-1.563E-3	-8.257E-2 ±i 3.278E-2
	-1.451E-3	-1.449E-3	-7.353E-2
	-0.135853	-0.136056	-0.122732
	-7.340E-2 ±i 2.046E-2	-7.371E-2 ±i 2.064E-2	-0.107702
	-0.126331	-0.125983	-0.104441 ±i 1.448E-3
	-0.103870	-0.103871	-1.532E-3
	-0.107568	-0.107568	-1.308E-3
	-0.109545	-0.109526	-0.104710
	-0.106783	-0.106827	

TABLE 4-9 Sensitivity of Closed-loop Evaluation System Eigenvalues to Perturbation in Estimator Parameters Alone

	PERCENTAGE CHANGE IN ESTIMATOR PARAMETERS		
	NOMINAL	5.0	10.0
RESIDUAL MODES	-1.885260 ±i 20.80360	-1.908230 ±i 21.11120	-1.931170 ±i 21.41470
	-0.106470 ±i 11.05890	-0.104528 ±i 11.07040	-0.102815 ±i 11.08100
	-4.749E-2 ±i 1.501200	-4.589E-2 ±i 1.499750	-4.437E-2 ±i 1.498340
	-6.772E-3 ±i 1.093150	-7.508E-3 ±i 1.093790	-8.462E-3 ±i 1.094310
	-2.407E-2 ±i 1.039420	-2.475E-2 ±i 1.038230	-2.487E-2 ±i 1.036820
	-2.201E-2 ±i 0.779488	-2.205E-2 ±i 0.776929	-2.106E-2 ±i 0.774636
	-7.747E-3 ±i 0.656300	-7.706E-3 ±i 0.656949	-7.693E-3 ±i 0.657519
CONTROLLED MODES (including compensator)	-0.948199	-1.030920	-1.110440
	-8.721E-2 ±i 0.887757	-9.068E-2 ±i 0.899155	-0.260180 ±i 0.882642
	-0.232469 ±i 0.798301	-0.245937 ±i 0.841404	-9.475E-2 ±i 0.912267
	-0.364507	-0.422208	-0.469872
	-0.122789 ±i 0.231737	-0.173503 ±i 0.226040	-0.206396 ±i 0.267616
	-3.498E-2 ±i 0.243471	-5.004E-2 ±i 0.242070	-6.371E-2 ±i 0.243431
	-0.271089	-0.193923	-0.227707
	-2.868E-2 ±i 0.233024	-3.076E-2 ±i 0.231551	-3.274E-2 ±i 0.230317
	-0.150244 ±i 0.133151	-0.180626 ±i 0.156962	-0.201637 ±i 0.177603
	-0.158051 ±i 0.131145	-0.117362 ±i 0.172011	-1.333E-2 ±i 0.177727
	-9.297E-3 ±i 0.157208	-1.376E-2 ±i 0.168149	-8.743E-2 ±i 0.164375
	-5.772E-3 ±i 0.148253	-7.067E-4 ±i 0.148535	1.263E-3 ±i 0.149065 *
	-1.294E-2 ±i 0.136720	-5.963E-3 ±i 0.144879	-1.329E-3 ±i 0.149127
	-5.729E-2 ±i 0.140760	-7.129E-2 ±i 0.132467	-7.963E-2 ±i 0.131834
	-7.193E-2 ±i 0.111687	-7.606E-2 ±i 0.108317	-8.274E-2 ±i 0.100858
	-0.175142 ±i 4.864E-2	-2.269E-2 ±i 7.466E-2	-1.974E-2 ±i 7.234E-2
	-2.632E-2 ±i 7.778E-2	-4.933E-2 ±i 7.296E-2	-4.557E-2 ±i 7.333E-2
	-5.641E-2 ±i 6.923E-2	-0.114195 ±i 3.543E-2	-0.109441 ±i 5.300E-2
	-1.564E-3	-1.563E-3	-1.563E-3
	-1.451E-3	-1.451E-3	-1.451E-3
	-0.135853	-0.183215	-0.147607
	-7.340E-2 ±i 2.046E-2	-0.148711 ±i 1.730E-2	-0.144876 ±i 1.723E-2
	-0.126331	-0.119124	-0.130184 ±i 4.182E-2
	-0.103870	-8.674E-2 ±i 1.854E-2	-8.923E-2 ±i 2.684E-2
	-0.107568	-7.222E-2	-6.238E-2
	-0.109545	-0.131078	
	-0.106783		

* UNSTABLE MODES

5.0 A ROBUSTNESS DESIGN CRITERION FOR INTEGRAL FEEDBACK COMPENSATORS

A general theory of robustness for multivariable feedback systems has evolved over the recent years (Refs. [11]-[16]). This theory holds a special appeal to designers of flexible spacecraft control systems because it presents a unified theoretical framework for dealing with such problems as dynamic spillover, modeling uncertainties and sensor/actuator selection. Indeed, a number of application papers have already appeared in the recent literature (Refs [17]-[19]).

Following a brief outline of the theoretical background, it will be pointed out that the commonly accepted robustness criteria may not be suitable for the class of integral feedback compensators discussed in this report. A modified criterion will be presented which will then be used as a design tool in an illustrative example drawn from the benchmark model of Ref.[1].

5.1 THEORETICAL BACKGROUND

The theory as expounded in the literature generally deals with a unity feedback multivariable system as shown in Fig. 5-1. The loop transfer function typically comprises the open-loop plant dynamics as well as any compensation in the loop. Suppose, due to modeling errors or parametric uncertainties somewhere in the loop, the actual transfer function matrix is given by $\tilde{G}(s)$. The perturbation may be represented as either of the additive type

$$\tilde{G}(s) = G(s) + \Delta G(s) \tag{5-1}$$

or of the multiplicative type

$$\tilde{G}(s) = (I + \Delta G(s))\, G(s). \tag{5-2}$$

The key question is that given the nominal closed-loop system is stable, under what constraint on the perturbation dynamics $\Delta G(s)$ is the perturbed unity feedback system still stable.

The robustness criteria may be derived from a generalization of the classical Nyquist criterion to multi-input-multi-output systems, and is well documented in the afore-mentioned literature. In short, the results are based on the properties of the return difference matrix $(I + G(s))$ and the ability to continuously deform its Nyquist diagram into one corresponding to the perturbed version $(I + \tilde{G}(s))$ without crossing the critical point (the origin).

Under the assumptions that

(a) the open-loop transfer function matrices $G(s)$ and $\tilde{G}(s)$ have the same number of unstable poles;

(b) the nominal closed-loop system (with zero perturbation) is asymptotically stable; and

(c) the eigenvalues of $\tilde{G}(s)$ along the imaginary axis coincide with those of the nominal system $G(s)$,

then the perturbed closed-loop system remains asymptotically stable if

$$\bar{\sigma}(\Delta G(j\omega)) < \underline{\sigma}[I + G(j\omega)], \quad \omega > 0 \tag{5-3}$$

in the case of additive perturbation (5-1), and

$$\bar{\sigma}(\Delta G(j\omega)) < \underline{\sigma}[I + G^{-1}(j\omega)], \quad \omega > 0 \tag{5-4}$$

in the case of multiplicative perturbation (5-2).

Here $\bar{\sigma}(\cdot)$ and $\underline{\sigma}(\cdot)$ denote the maximum and minimum singular values, respectively, of a matrix; they are defined as follows:

$$\bar{\sigma}(A) := \max_{\|x\|=1} \|Ax\| = \sqrt{\text{max eigenvalue of } A^*A} \tag{5-5}$$

$$\underline{\sigma}(A) := \min_{\|x\|=1} \|Ax\| = \sqrt{\text{min eigenvalue of } A^*A} \tag{5-6}$$

where $(\cdot)^*$ denotes the conjugate transpose of complex matrix. Note that the maximum singular value of a matrix is in fact a standard matrix norm.

Thus, the condition (5-3) or (5-4) effectively imposes a frequency-dependent upper bound on the norm of the perturbation matrix. Conversely, they also specify the minimum "gains" the return difference matrix should have in order to ensure robustness.

Although these are only **sufficient** conditions, they are applicable to a broad class of perturbation dynamics. Indeed, the latter need not assume any specific structure at all in order for the theory to apply. This is a very useful feature in the case of flexible spacecraft where the control system is invariably based on a finite-dimensional model of an infinite dimensional system. Hence, the specific order, and therefore, structure, of the residual dynamics is never completely known. We shall explore this further in the next section.

5.2 ROBUSTNESS CRITERIA FOR FLEXIBLE SPACECRAFT

A flexible spacecraft control system has the general configuration shown in Fig. 5-2 in which the residual dynamics may be represented as either additive perturbation

$$P(s) = P_c(s) + P_R(s), \tag{5-7}$$

or as multiplicative perturbation

$$P(s) = (I + P_R P_c^{-1}) P_c(s), \tag{5-8}$$

provided the necessary inverse matrix exists. Since the invertibility of P_c is generally not guaranteed, nor are the numbers of inputs and outputs typically the same, the additive formulation (5-7) is usually the more appropriate one to use.

In order to apply the robustness result of the last section, it is first necessary to obtain the return difference matrix for an equivalent unity feedback system as shown in Fig. 5-1. This is done classically by "breaking the loop" at the appropriate point; the return difference matrix is then defined for the particular node at which the loop is broken. Clearly, the robustness result would then apply only to perturbation injected at this point in the loop.

Obviously, the form of the return difference matrix depends entirely on the choice of the loop-breaking point; this in turn affects the outcome of the robustness criteria (5-3) and (5-4). For instance, with the loop broken at point 1 at the output of the system of Fig. 5-2, the return difference matrix is given by

$$I + PH(s). \tag{5-9}$$

On the other hand, the return difference matrix corresponding to break point 2 at the input to the system is

$$I + HP(s). \tag{5-10}$$

In the equivalent unity feedback formulation, the loop transfer matrix for (5-9) is

$$G(s) := PH(s),$$

but is given by

$$G(s) := HP(s)$$

for (5-10).

For our demonstration, let us adopt (5-9), i.e., loop-break point at the output. The perturbation dynamics due to the residual modes is then represented as $P_R(s)\,H(s)$.

Direct application of the robustness criterion (5-3) thus yields

$$\bar{\sigma}\left(P_R(j\omega)H(j\omega)\right) < \underline{\sigma}\left[I + P_c(j\omega)H(j\omega)\right], \omega > 0. \qquad (5\text{-}11)$$

A sufficient condition for the above inequality is

$$\bar{\sigma}\left(P_R(j\omega)\right) < \underline{\sigma}\left[I + P_c(j\omega)H(j\omega)\right]/\bar{\sigma}\left(H(j\omega)\right), \omega > 0. \qquad (5\text{-}12)^*$$

Furthermore, when the compensator is invertible, (5-12) becomes

$$\bar{\sigma}\left(P_R(j\omega)\right) < \underline{\sigma}\left[H^{-1}(j\omega) + P_c(j\omega)\right], \omega > 0. \qquad (5\text{-}13)^*$$

The criteria (5-11)-(5-13) have appeared frequently in the literature (Refs. [16]-[19]) for the obvious reason of simplicity. Unfortunately, they are not appropriate when the compensator contains integral feedback of the kind described earlier in this report. The right-hand sides of (5-12) and (5-13) could present numerical difficulties at very low frequencies. At the same time, the left-hand side of (5-11) approaches infinity so that the bound becomes meaningless.

An alternative formulation which does not rely on the invertibility of H would overcome these problems at low frequencies. This is obtained by defining

$$W(j\omega) := H(j\omega)\left[I + P_c(j\omega)H(j\omega)\right]^{-1}, \omega > 0. \qquad (5\text{-}14)$$

---

*In deriving (5-12) and (5-13), we have made use of the following properties of singular values:

(a) $\bar{\sigma}(AB) \leq \bar{\sigma}(A)\,\bar{\sigma}(B)$
(b) $\underline{\sigma}(A)\,\underline{\sigma}(B) \leq \underline{\sigma}(AB)$
(c) $\bar{\sigma}(A^{-1}) = 1/\underline{\sigma}(A)$

The invertibility of the return difference function $(I+P_cH)$ is guaranteed since, by assumption, the closed-loop nominal system for the controlled modes is asymptotically stable. Using a similar approach to Ref.[14], we obtain the following result:

THEOREM 5-1

Given that $(I+P_cH)^{-1}$ exists and is asymptotically stable; assume $P_R(s)$ is also asymptotically stable. Then

$$\bar{\sigma}\left(P_R(j\omega)\,W(j\omega)\right) < 1\,, \quad \omega > 0 \tag{5-15}$$

ensures that the closed-loop system with $H(s)$ applied to the evaluation model (5-7) is asymptotically stable.

The proof is outlined in Appendix I. An interesting corollary is the following:

COROLLARY

A sufficient condition for (5-15) is

$$\bar{\sigma}\left(P_R(j\omega)\right) < 1/\bar{\sigma}\left(W(j\omega)\right)\,, \quad \omega > 0\,. \tag{5-16}$$

Note that conditions (5-15) and (5-16) hold whenever (5-11) and (5-12) hold, respectively. However, due to pole-zero cancellations in the formulation of $W(s)$ in (5-14), the criterion (5-16) exhibits none of the afore-mentioned numerical difficulties at low frequencies.

5.3 USE OF ROBUSTNESS CRITERION FOR COMPENSATOR DESIGN

In the early part of this report, we have presented a number of compensator designs which are robust in the presence of residual dynamics and parametric uncertainties. The approach taken there was by searching among the steady state Riccati solutions for the optimal control and estimation problems. Though brute-force in appearance, the method turned out to be very effective in the design cases considered. Nevertheless, robustness of the nominal design must still be verified independently via sensitivity analysis.

The robustness results presented in this section, however, has created a design approach through which robustness is guaranteed for a broad class of (possibly unstructured) perturbation dynamics. Furthermore, the effects of perturbation applied at various points in the system, such as sensor or actuator failures, may be isolated and studied through appropriate selection of the loop-breaking points. Consequently, the compensator design may be customized to handle certain specific types of perturbation pertinent to the application at hand.

The key here is to vary the compensator parameters so as to enforce the compliance of (5-15), (5-16) or any other robustness criterion obtained for the corresponding loop-breaking point. There are many ways in which the compensator parameters could be varied, parameter optimization being the most common approach (e.g., Ref.[17]). In the next section, we shall demonstrate how the same search technique described earlier may be used in combination with the robustness criterion (5-16) as a design tool.

5.4 A SINGLE INPUT-SINGLE OUTPUT EXAMPLE

We present here a simple example to demonstrate the principle behind the use of the robustness criterion (5-16) for design purposes. For the evaluation model, we select modes 1 and 3 of the benchmark model from Ref.[1] together with the first components in u and y as input and output, respectively. The system model may be written in the form

$$\begin{aligned} \dot{x}_p &= A_p x_p + b_p u + b_p u_d \\ y &= c_p^T x_p + w_m , \end{aligned} \qquad (5\text{-}17)$$

where

$$x_p := \begin{bmatrix} \eta_1 \\ \eta_3 \\ \dot{\eta}_1 \\ \dot{\eta}_3 \end{bmatrix} , \qquad u := \beta_1 , \qquad y := f^{-1}\delta_1$$

The disturbance input and measurement noise are represented by u_d and w_m , respectively. The system matrices for this model are shown in Table 5-1(a).

For the design model, we arbitrarily choose the high frequency mode so as to create a non-trivial situation with spillover from the low frequency mode. The model is described by

$$\begin{aligned} \dot{x}_c &= A_c x_c + b_c u + b_c u_d \\ y &= c_c^T x_c + w_m \end{aligned} \qquad (5\text{-}18)$$

where

$$x_c := \begin{bmatrix} \eta_3 \\ \dot{\eta}_3 \end{bmatrix} .$$

The system matrices are listed in Table 5-1(b). For this example, the transfer functions for the controlled and residual dynamics are given by

$$P_c(s) = \frac{4.758 \times 10^{-12}}{s^2 + (3.409 \times 10^{-3})s + 5.737 \times 10^{-2}} \tag{5-19}$$

and

$$P_R(s) = \frac{9.751 \times 10^{-7}}{s^2 + (1.846 \times 10^{-3})s + 1.546 \times 10^{-2}} , \tag{5-20}$$

respectively

As in (4-14), the tracking compensator for the design model is given by

$$\begin{aligned} \dot{x}_1 &= A_1 x_1 + b_1 y + b_o y_o \\ u &= -d_1^T x_1 + d_o^T y_o \end{aligned} \tag{5-21}$$

where the compensator state vector $x_1 := \begin{bmatrix} \hat{x}_c \\ p \end{bmatrix} \in \mathbb{R}^3$

consists of 2 estimated states for x_c and the output of a single integrator for disturbance rejection. For this demonstration, the control output reference y_o may be set to zero without affecting our conclusions on stability.

To compute the controller gains (d_1, d_o), we choose to minimize the cost function

$$J = \int_0^\infty y^2 + \rho\,(10 u^2)\; dt . \tag{5-22}$$

The disturbance input and measurement noise are again assumed to be uncorrelated zero-mean white noise processes with intensities of 1.0 and (10) ρ , respectively. As before, the parameter ρ will be used to search among the steady state Riccati solutions of the control and estimation problems defined above. However, in this case, instead of closed-loop eigenvalues, we shall use condition (5-16) as the search criterion.

The design iteration proceeds as follows. For any value of ρ , the transfer function of the corresponding compensator (5-21) is computed; this is easily done using KEDDC commands. This then allows the function W(s) of (5-14) to be computed. From this, the criterion (5-16) is then examined by comparing the singular value plots of the two sides of the inequality.

Figure 5-3 displays a typical case where the robustness criterion (5-16) is violated at the frequency (0.124 rad/s) of the residual mode, indicating that the spillover from this mode could cause instability problems. The compensator parameter are then reiterated with a different value for ρ until the criterion (5-16) is finally satisfied over all the frequencies of interest.

Figure 5-4 describes a typical iteration sequence for value of ρ ranging from 0.0001 to 0.1. The corresponding transfer functions for the compensators are listed in Table 5-2. It is clear that at values of ρ above 0.01, robustness to spillover is assured. This is further confirmed by the evaluation system closed-loop eigenvalues displayed in Table 5-3.

An interesting observation from this example is that, contrary to common belief, the designs obtained from the robustness criterion (5-16) are by no means conservative. Indeed, by comparing the eigenvalues listed in Table 5-3 to the singular value plots of Fig. 5-4, one sees an almost one-to-one relationship between stability and satisfaction of the criterion. However, whether this relationship will hold in the multi-input-multi-output case is still a subject for speculation.

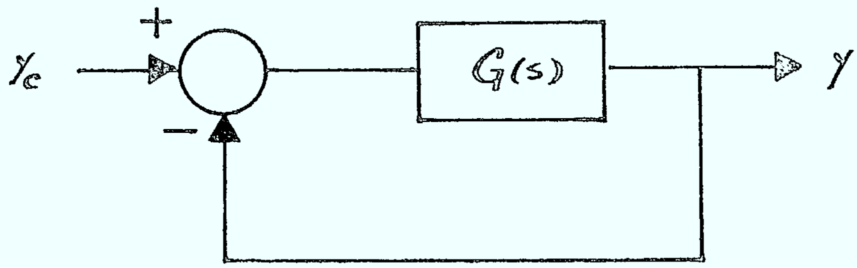

FIGURE 5-1   A Unity Feedback Sy stem

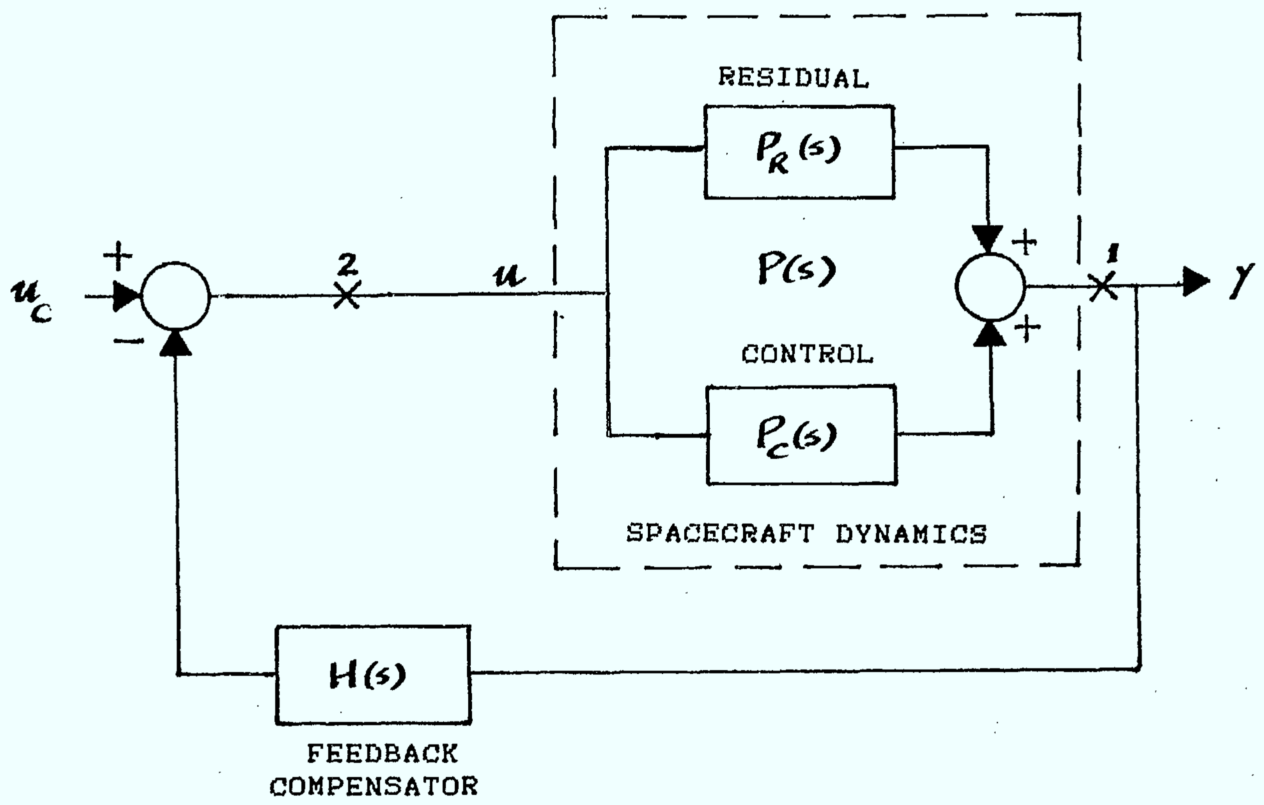

FIGURE 5-2 A Control System Representation for Flexible Spacecraft

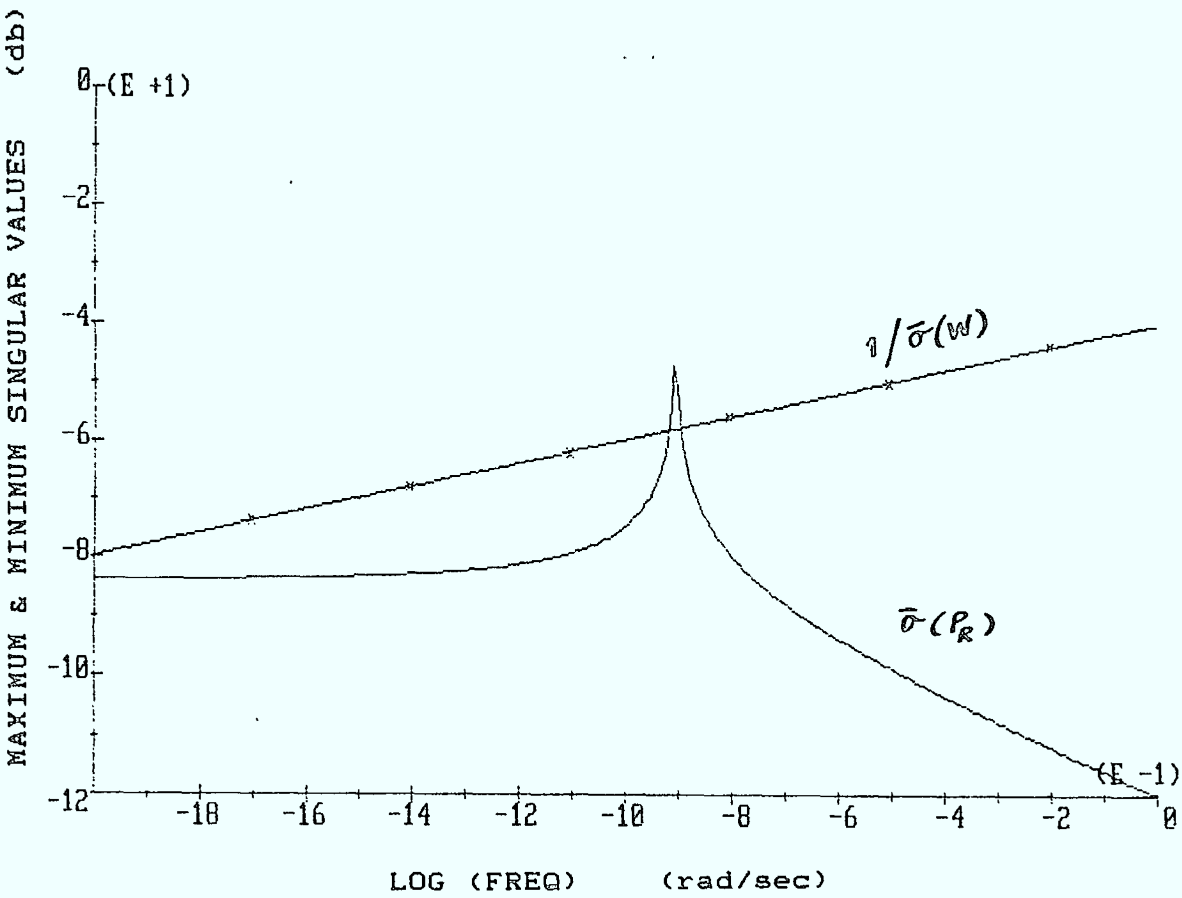

FIGURE 5-3 A Case of Violation of Robustness Criterion (5-16)

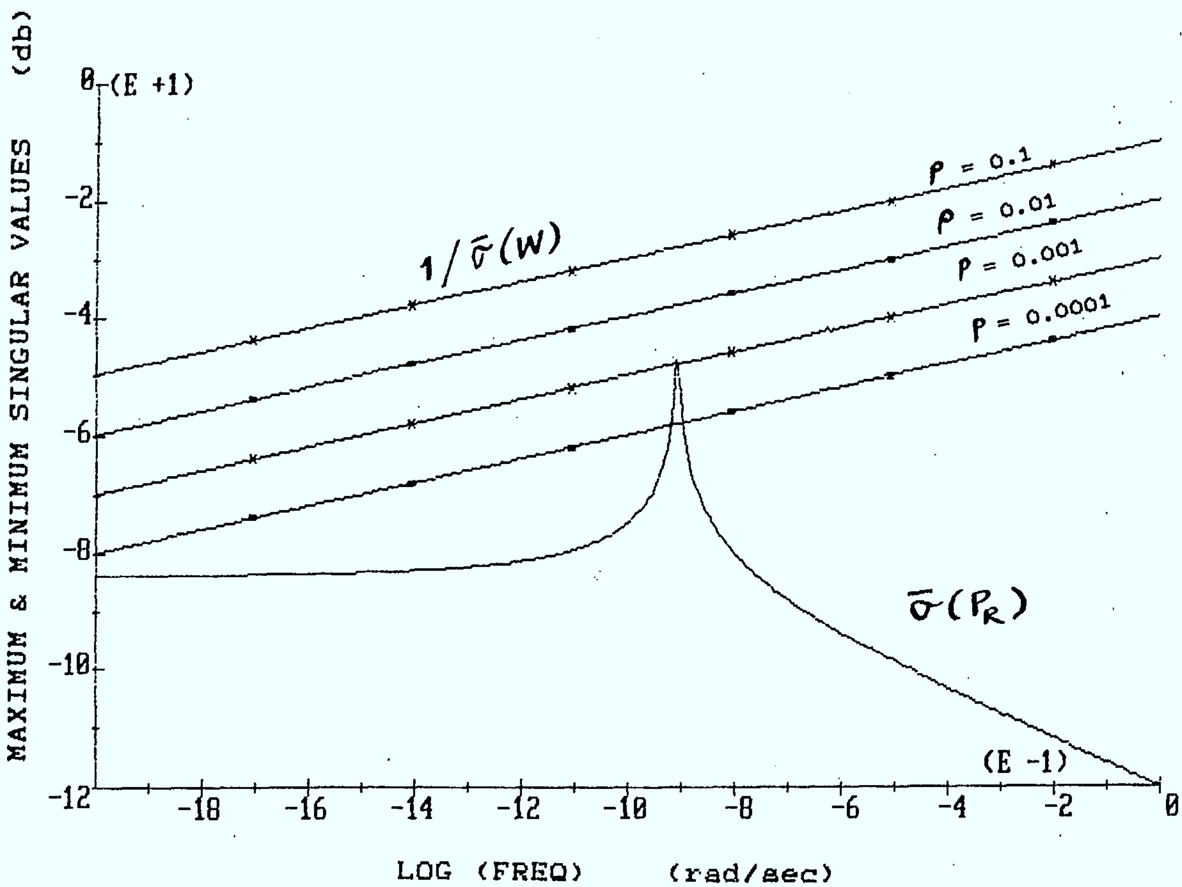

FIGURE 5-4 Design Iteration Using Robustness Criterion (5-16)

TABLE 5-1 Model Data for Robustness Criterion Design Example

(a) EVALUATION MODEL

A Matrix:

$$\begin{bmatrix} 0.0 & 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 1.0 \\ -1.54628E-2 & 0.0 & -1.846E-3 & 0.0 \\ 0.0 & -5.737217E-2 & 0.0 & -3.409E-3 \end{bmatrix}$$

B Matrix:

$$\begin{bmatrix} 0.0 \\ 0.0 \\ -5.553E-4 \\ -1.500E-6 \end{bmatrix}$$

C Matrix:

$$\begin{bmatrix} -1.756E-3 & -3.172E-6 & 0.0 & 0.0 \end{bmatrix}$$

(b) DESIGN MODEL

A Matrix:

$$\begin{bmatrix} 0.0 & 1.0 \\ -5.737217E-2 & -3.409E-3 \end{bmatrix}$$

B Matrix:

$$\begin{bmatrix} 0.0 \\ -1.500E-6 \end{bmatrix}$$

C Matrix:

$$\begin{bmatrix} -3.172E-6 & 0.0 \end{bmatrix}$$

TABLE 5-2 Compensator Candidates for Robustness Criterion Design Example

ρ	COMPENSATOR TRANSFER FUNCTION
0.0001	$H(s) = \dfrac{5.737 + 0.3409s + 100s^2}{s(0.05737 + 0.003439s + s^2)}$
0.001	$H(s) = \dfrac{1.814 + 0.1078s + 31.62s^2}{s(0.05737 + 0.003417s + s^2)}$
0.01	$H(s) = \dfrac{0.5737 + 0.03409s + 10s^2}{s(0.05737 + 0.003411s + s^2)}$
0.1	$H(s) = \dfrac{0.1814 + 0.01078s + 3.162s^2}{s(0.05737 + 0.003410s + s^2)}$

TABLE 5-3 Closed-loop Evaluation System Eigenvalues for Robustness Criterion Design Example

	CONTROLLED MODES (including compensator)	RESIDUAL MODES
ρ = 0.0001	-6.295E-3 -1.719E-3 ±i 0.239519 -1.705E-3 ±i 0.239519	2.224E-3 ±i 0.124442 *
ρ = 0.001	-1.994E-3 -1.708E-3 ±i 0.239519 -1.705E-3 ±i 0.239519	7.407E-5 ±i 0.124351 *
ρ = 0.01	-6.306E-4 -1.705E-3 ±i 0.239519 -1.706E-3 ±i 0.239519	-6.077E-4 ±i 0.124345
ρ = 0.1	-1.994E-4 -1.705E-3 ±i 0.239519 -1.705E-3 ±i 0.239519	-8.233E-4 ±i 0.124345

* UNSTABLE MODES

6.0 CONCLUSIONS AND RECOMMENDATIONS

Contrary to popular opinion, it has been demonstrated that an estimator-based compensator could be designed to retain the robustness properties with regard to parametric variation and spillover from unmodeled dynamics. This is accomplished through a simple search technique. The effectiveness of the method has been amply demonstrated by the robust regulation and tracking compensator designs presented here for the MSAT model.

On the theoretical front, a design criterion has been established for compensators with integral feedback which will guarantee robustness to withstand spillover from unmodeled dynamics. The method could be used to study the robustness effects of a broad class of (possibly unstructured) perturbation injected at virtually any point in the system. The single input-single output example presented here indicates that the designs that result from the use of this criterion are not overly conservative even through this has been a common source of criticism of singular value-based robustness criteria. However, the simple example studied here has by no means revealed the full potential (and, of course, pitfalls) of the design criterion in question; further evaluation is necessary.

The capabilities of the design package KEDDC has been amply demonstrated through this study. Needless to say, there still exist areas in which improvements to the current version would be desirable for future use. A case in point is the lack of a capability to perform transfer function matrix algebra which would greatly facilitate the utilization of the robustness criteria discussed in Section 5 as a design tool. On the whole, however, our experience indicates that there has been a significant increase in design efficiency through the use of KEDDC. Though not readily quantifiable, the productivity increase that results, when compared to a similar design exercise undertaken in an earlier study, could easily be a factor of ten or more.

There are several avenues along which fruitful follow-on activities may be pursued:

a) Verification of the tracking compensator design via digital simulation.

b) Verification of the robust design methodology with hardware in a proof-of-concept experiment.

c) Further investig ation of the singular value-based robustness design criteria in a multi-input/multi-output setting.

d) Upgrade the design capabilities of KEDDC particularly in regard to transfer function matrix algebra.

The multivariable singular value-based robustness design theory certainly represents one of the more significant results developed in recent years. The full potential of the method has barely been explored in this study. Further research efforts even from the purely theoretical standpoint is necessary in order to consolidate the various design concepts which have originated from this theory.

6.0 CONCLUSIONS AND RECOMMENDATIONS

With regard to (a) and (b), there are currently plans proposed for hardware demonstration of flexible structure control technology in connection with either third-generation spacecraft or the development of manipulators for space station applications. The experience from this study will serve well towards laying the groundwork for any activities in those areas.

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APPENDIX A

DESIGN MODEL DATA FROM REF. [4]

Listed in the following are the design system matrices for the continuous-time model (A_c, B_c , C_c) and their discretized version ($\bar{A}_c$, $\bar{B}_c$, $\bar{C}_c$) obtained with KEDDC.

Matrix A_c :

MATRIX A FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 1
DIMENSION 22X22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	1.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	1.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	1.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_c (cont'd.) :

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	1.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	1.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	1.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	1.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	-1.546281E-02
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	1.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	1.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	-1.846000E-03	-2.519000E-06
(20)	-5.737217E-02	0.00000	0.00000	-2.519000E-06	-3.409000E-03
(21)	0.00000	-.309465	0.00000	1.700000E-03	6.900000E-06
(22)	0.00000	0.00000	-.607833	-3.255000E-03	-1.146000E-05

Matrix A_c (cont'd.) :

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	0.00000	0.00000
(16)	0.00000	0.00000
(17)	1.00000	0.00000
(18)	0.00000	1.00000
(19)	1.700000E-03	-3.255000E-03
(20)	6.900000E-06	-1.146000E-05
(21)	-1.711000E-02	4.585000E-03
(22)	4.585000E-03	-4.215000E-02

Matrix B_c :

MATRIX B FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 2
DIMENSION 22X10, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	8.410000E-03	8.410000E-03	-8.410000E-03
(9)	0.00000	0.00000	-1.457000E-02	1.457000E-02	1.457000E-02
(10)	0.00000	0.00000	5.729000E-03	-5.729000E-03	-5.729000E-03
(11)	0.00000	0.00000	3.806000E-03	3.811000E-03	-3.806000E-03
(12)	0.00000	0.00000	1.022000E-02	-7.078000E-03	7.133000E-03
(13)	6.944000E-03	0.00000	1.289000E-03	4.539000E-05	-4.112000E-05
(14)	6.791000E-08	6.921000E-03	-8.075000E-04	8.081000E-04	8.094000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-5.553000E-04	-2.199000E-06	6.530000E-03	-3.478000E-03	3.488000E-03
(20)	-1.500000E-06	-2.577000E-03	-3.368000E-03	3.370000E-03	3.419000E-03
(21)	8.518000E-04	1.731000E-06	-2.485000E-02	2.639000E-02	-2.653000E-02
(22)	4.838000E-03	-2.422000E-06	-6.475000E-04	-3.014000E-03	3.025000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	-8.410000E-03	8.410000E-03	8.410000E-03	-8.410000E-03	-8.410000E-03
(9)	-1.457000E-02	-1.457000E-02	1.457000E-02	1.457000E-02	-1.457000E-02
(10)	5.729000E-03	-2.869000E-02	2.869000E-02	2.869000E-02	-2.869000E-02
(11)	-3.811000E-03	-1.906000E-02	-1.908000E-02	1.906000E-02	1.908000E-02
(12)	-1.027000E-02	9.299000E-03	9.284000E-03	-9.299000E-03	-9.284000E-03
(13)	-1.293000E-03	-2.675000E-04	-2.702000E-04	2.675000E-04	2.702000E-04
(14)	-8.100000E-04	9.735000E-04	-9.725000E-04	-9.735000E-04	9.725000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-6.539000E-03	-4.826000E-02	-4.783000E-02	4.826000E-02	4.783000E-02
(20)	-3.421000E-03	-.108700	.108500	.108700	-.108500
(21)	2.499000E-02	5.095000E-02	5.079000E-02	-5.095000E-02	-5.079000E-02
(22)	6.358000E-04	-.241800	-.241300	.241800	.241300

Matrix C_c :

MATRIX C FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 3
DIMENSION 13X22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.682000E-02	0.00000	0.00000	7.617000E-03	3.139000E-03
(2)	0.00000	1.682000E-02	-6.615000E-03	2.807000E-06	3.172000E-05
(3)	0.00000	0.00000	9.094000E-04	-3.859000E-07	-9.257000E-07
(4)	0.00000	0.00000	0.00000	1.047000E-03	7.331000E-04
(5)	0.00000	0.00000	0.00000	0.00000	2.003000E-03
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	1.334000E-03	5.777000E-07	0.00000	0.00000	0.00000
(2)	2.464000E-06	9.338000E-04	0.00000	0.00000	0.00000
(3)	-9.174000E-08	-4.708000E-05	0.00000	0.00000	0.00000
(4)	1.210000E-04	1.119000E-07	0.00000	0.00000	0.00000
(5)	1.441000E-04	2.213000E-07	0.00000	0.00000	0.00000
(6)	6.944000E-03	6.791000E-08	0.00000	0.00000	0.00000
(7)	0.00000	6.921000E-03	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	3.051000E-03
(2)	0.00000	0.00000	0.00000	0.00000	5.393000E-06
(3)	0.00000	0.00000	0.00000	0.00000	-8.282000E-07
(4)	0.00000	0.00000	0.00000	0.00000	-5.856000E-04
(5)	0.00000	0.00000	0.00000	0.00000	1.157000E-03
(6)	0.00000	0.00000	0.00000	0.00000	-5.553000E-04
(7)	0.00000	0.00000	0.00000	0.00000	-2.199000E-06
(8)	0.00000	0.00000	0.00000	0.00000	-7.672000E-02
(9)	0.00000	0.00000	0.00000	0.00000	-1.057000E-04
(10)	0.00000	0.00000	0.00000	0.00000	9.647000E-05
(11)	0.00000	0.00000	0.00000	0.00000	4.200000E-06
(12)	0.00000	0.00000	0.00000	0.00000	5.736000E-05
(13)	0.00000	0.00000	0.00000	0.00000	3.335000E-03

Matrix C_c (cont'd.) :

	(16)	(17)	(18)	(19)	(20)
(1)	1.986000E-06	1.541000E-03	-3.661000E-03	0.00000	0.00000
(2)	3.920000E-03	-8.289000E-05	6.760000E-06	0.00000	0.00000
(3)	-9.888000E-04	8.859000E-07	-4.329000E-06	0.00000	0.00000
(4)	2.133000E-07	-3.964000E-04	-5.918000E-03	0.00000	0.00000
(5)	5.812000E-06	-5.932000E-03	2.746000E-04	0.00000	0.00000
(6)	-1.500000E-06	8.518000E-04	4.838000E-03	0.00000	0.00000
(7)	-2.577000E-03	1.731000E-06	-2.422000E-06	0.00000	0.00000
(8)	-1.386000E-04	.121800	-.270900	0.00000	0.00000
(9)	-2.193000E-02	-5.374000E-05	-1.934000E-04	0.00000	0.00000
(10)	7.066000E-02	-4.218000E-05	1.590000E-04	0.00000	0.00000
(11)	3.425000E-03	-2.497000E-06	6.796000E-06	0.00000	0.00000
(12)	1.776000E-06	-1.050000E-03	-1.114000E-02	0.00000	0.00000
(13)	8.002000E-06	-6.323000E-03	-6.592000E-04	0.00000	0.00000

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000

Matrix $\bar{A}_c$:

MATRIX A FROM FILE DZM , BLOCKNO. 3, MATRIXNO. 1
DIMENSION 22*22, SAMPLING TIME = 10.000

	(1)	(2)	(3)	(4)	(5)
(1)	1.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	1.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	1.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	1.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	1.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	10.0000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	10.0000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	10.0000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	1.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	1.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	1.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	1.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	1.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix $\bar{A}_c$ (cont'd) :

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	10.0000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	10.0000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	10.0000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	10.0000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	1.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	1.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	1.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	1.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	.325515
(16)	0.00000	0.00000	0.00000	0.00000	4.342479E-06
(17)	0.00000	0.00000	0.00000	0.00000	-7.748331E-04
(18)	0.00000	0.00000	0.00000	0.00000	5.520644E-04
(19)	0.00000	0.00000	0.00000	0.00000	-.116671
(20)	0.00000	0.00000	0.00000	0.00000	9.611996E-07
(21)	0.00000	0.00000	0.00000	0.00000	3.063950E-05
(22)	0.00000	0.00000	0.00000	0.00000	2.217990E-05

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	1.611205E-05	-1.550712E-02	2.170130E-02	7.54524	-6.216204E-05
(16)	-.716977	-3.355321E-05	2.286677E-05	-6.216204E-05	2.78695
(17)	-6.220484E-06	.680451	2.031416E-02	-1.981497E-03	-3.781729E-05
(18)	2.158350E-06	1.034251E-02	7.101364E-02	-1.434404E-03	1.607905E-05
(19)	3.566372E-06	6.132033E-04	8.718777E-04	.311588	-2.679734E-06
(20)	-.159894	1.170312E-05	-9.773378E-06	-2.679734E-06	-.726478
(21)	2.169660E-06	.337142	-5.540125E-03	-2.652882E-03	-1.370812E-05
(22)	-9.224903E-07	-2.820633E-03	-.630669	-2.807082E-03	-9.720508E-06

Matrix $\bar{A}_c$ (cont'd) :

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	-1.981497E-03	-1.434404E-03
(16)	-3.781729E-05	1.607905E-05
(17)	-1.08943	9.114553E-03
(18)	9.114553E-03	1.03757
(19)	-2.652882E-03	-2.807082E-03
(20)	-1.370812E-05	-9.720508E-06
(21)	.699130	1.494138E-02
(22)	1.494138E-02	2.732654E-02

Matrix $\bar{B}_c$:

MATRIX B FROM FILE DZM , BLOCKNO. 3, MATRIXNO. 2
DIMENSION 22*10, SAMPLING TIME = 10.000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	.420500	.420500	-.420500
(2)	0.00000	0.00000	-.728500	.728500	.728500
(3)	0.00000	0.00000	.286450	-.286450	-.286450
(4)	0.00000	0.00000	.190300	.190550	-.190300
(5)	0.00000	0.00000	.511000	-.353900	.356650
(6)	.347200	0.00000	6.445000E-02	2.269500E-03	-2.056000E-03
(7)	3.395500E-06	.346050	-4.037500E-02	4.040500E-02	4.047000E-02
(8)	0.00000	0.00000	8.410000E-02	8.410000E-02	-8.410000E-02
(9)	0.00000	0.00000	-.145700	.145700	.145700
(10)	0.00000	0.00000	5.729000E-02	-5.729000E-02	-5.729000E-02
(11)	0.00000	0.00000	3.806000E-02	3.811000E-02	-3.806000E-02
(12)	0.00000	0.00000	.102200	-7.078000E-02	7.133000E-02
(13)	6.944000E-02	0.00000	1.289000E-02	4.539000E-04	-4.112000E-04
(14)	6.791000E-07	6.921000E-02	-8.075000E-03	8.081000E-03	8.094000E-03
(15)	-2.435214E-02	-9.502308E-05	.283616	-.150281	.150708
(16)	-4.482421E-05	-7.712189E-02	-.100799	.100858	.102316
(17)	6.900419E-04	1.478754E-06	-2.531128E-02	2.717676E-02	-2.732045E-02
(18)	7.385555E-03	-3.584077E-06	-3.921213E-04	-5.364395E-03	5.385273E-03
(19)	-4.198499E-03	-1.643175E-05	4.932079E-02	-2.629052E-02	2.636581E-02
(20)	-4.100335E-06	-7.181981E-03	-9.385938E-03	9.391205E-03	9.529431E-03
(21)	-8.827836E-04	-1.806074E-06	2.705373E-02	-2.877088E-02	2.892323E-02
(22)	5.028323E-03	-2.535498E-06	-9.077439E-04	-2.881659E-03	2.891891E-03

	(6)	(7)	(8)	(9)	(10)
(1)	-.420500	.420500	.420500	-.420500	-.420500
(2)	-.728500	-.728500	.728500	.728500	-.728500
(3)	.286450	-1.43450	1.43450	1.43450	-1.43450
(4)	-.190550	-.953000	-.954000	.953000	.954000
(5)	-.513500	.464950	.464200	-.464950	-.464200
(6)	-6.465000E-02	-1.337500E-02	-1.351000E-02	1.337500E-02	1.351000E-02
(7)	-4.050000E-02	4.867500E-02	-4.862500E-02	-4.867500E-02	4.862500E-02
(8)	-8.410000E-02	8.410000E-02	8.410000E-02	-8.410000E-02	-8.410000E-02
(9)	-.145700	-.145700	.145700	.145700	-.145700
(10)	5.729000E-02	-.286900	.286900	.286900	-.286900
(11)	-3.811000E-02	-.190600	-.190800	.190600	.190800
(12)	-.102700	9.299000E-02	9.284000E-02	-9.299000E-02	-9.284000E-02
(13)	-1.293000E-02	-2.675000E-03	-2.702000E-03	2.675000E-03	2.702000E-03
(14)	-8.100000E-03	9.735000E-03	-9.725000E-03	-9.735000E-03	9.725000E-03
(15)	-.284000	-2.09388	-2.07521	2.09388	2.07521
(16)	-.102376	-3.25304	3.24711	3.25304	-3.24711
(17)	2.545504E-02	5.826130E-02	5.812448E-02	-5.826130E-02	-5.812448E-02
(18)	3.701373E-04	-.369533	-.368787	.369533	.368787
(19)	-4.938854E-02	-.363881	-.360650	.363881	.360650
(20)	-9.534698E-03	-.302945	.302382	.302945	-.302382
(21)	-2.720608E-02	-5.761084E-02	-5.744104E-02	5.761084E-02	5.744104E-02
(22)	8.967841E-04	-.250352	-.249832	.250352	.249832

Matrix $\bar{C}_c$:

MATRIX C FROM FILE DZM , BLOCKNO. 3, MATRIXNO. 3
DIMENSION 13X22, SAMPLING TIME = 10.000

	(1)	(2)	(3)	(4)	(5)
(1)	1.682000E-02	0.00000	0.00000	7.617000E-03	3.139000E-03
(2)	0.00000	1.682000E-02	-6.615000E-03	2.807000E-06	3.172000E-05
(3)	0.00000	0.00000	9.094000E-04	-3.859000E-07	-9.257000E-07
(4)	0.00000	0.00000	0.00000	1.047000E-03	7.331000E-04
(5)	0.00000	0.00000	0.00000	0.00000	2.003000E-03
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	1.334000E-03	5.777000E-07	0.00000	0.00000	0.00000
(2)	2.464000E-06	9.338000E-04	0.00000	0.00000	0.00000
(3)	-9.174000E-08	-4.708000E-05	0.00000	0.00000	0.00000
(4)	1.210000E-04	1.119000E-07	0.00000	0.00000	0.00000
(5)	1.441000E-04	2.213000E-07	0.00000	0.00000	0.00000
(6)	6.944000E-03	6.791000E-08	0.00000	0.00000	0.00000
(7)	0.00000	6.921000E-03	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	3.051000E-03
(2)	0.00000	0.00000	0.00000	0.00000	5.393000E-06
(3)	0.00000	0.00000	0.00000	0.00000	-8.282000E-07
(4)	0.00000	0.00000	0.00000	0.00000	-5.856000E-04
(5)	0.00000	0.00000	0.00000	0.00000	1.157000E-03
(6)	0.00000	0.00000	0.00000	0.00000	-5.553000E-04
(7)	0.00000	0.00000	0.00000	0.00000	-2.199000E-06
(8)	0.00000	0.00000	0.00000	0.00000	-7.672000E-02
(9)	0.00000	0.00000	0.00000	0.00000	-1.057000E-04
(10)	0.00000	0.00000	0.00000	0.00000	9.647000E-05
(11)	0.00000	0.00000	0.00000	0.00000	4.200000E-06
(12)	0.00000	0.00000	0.00000	0.00000	5.736000E-05
(13)	0.00000	0.00000	0.00000	0.00000	3.335000E-03

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Matrix $\bar{C}_c$ (cont'd):

	(16)	(17)	(18)	(19)	(20)
(1)	1.986000E-06	1.541000E-03	-3.661000E-03	0.00000	0.00000
(2)	3.920000E-03	-8.289000E-05	6.760000E-06	0.00000	0.00000
(3)	-9.888000E-04	8.859000E-07	-4.329000E-06	0.00000	0.00000
(4)	2.133000E-07	-3.964000E-04	-5.918000E-03	0.00000	0.00000
(5)	5.812000E-06	-5.932000E-03	2.746000E-04	0.00000	0.00000
(6)	-1.500000E-06	8.518000E-04	4.838000E-03	0.00000	0.00000
(7)	-2.577000E-03	1.731000E-06	-2.422000E-06	0.00000	0.00000
(8)	-1.386000E-04	.121800	-.270900	0.00000	0.00000
(9)	-2.193000E-02	-5.374000E-05	-1.934000E-04	0.00000	0.00000
(10)	7.066000E-02	-4.218000E-05	1.590000E-04	0.00000	0.00000
(11)	3.425000E-03	-2.497000E-06	6.796000E-06	0.00000	0.00000
(12)	1.776000E-06	-1.050000E-03	-1.114000E-02	0.00000	0.00000
(13)	8.002000E-06	-6.323000E-03	-6.592000E-04	0.00000	0.00000

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000

APPENDIX B

DESIGN RESULTS FROM REF.[4]

The following contains the weighting matrices ($\mathbb{Q}$, $\mathbb{R}$), the compensator parameters and the design system closed-loop eigenvalues from the regulator designs obtained in Ref.[4] for the following cases:

B-1: Discrete-time full-state feedback with ($\mathbb{Q}$, $\mathbb{R}$) taken from the continuous-time (Dynacon) version -- RICMATF

B-2: Same as above, but with Q discretized -- RICQF

B-3: Continuous-time decoupled observer with spillover suppression -- DECMATS

Matrix Q :

```
MATRIX QE              0  30  BY  30
 1   1.0000E+00  0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 2   0.          1.0000E+00  0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 3   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 4   0.          0.          0.          1.6940E-06 -7.0190E-10 -1.6840E-09 -1.0000E-10  1.2010E-05
     0.          0.          0.          0.          0.          0.          0.          0.
    -8.9230E-10 -3.8200E-07 -1.2370E-06 -3.7370E-10 -7.3630E-10 -4.5310E-09  8.7910E-06  3.1030E-09
    -5.6620E-06  1.6660E-09 -6.0460E-10  0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 5   0.          0.          0.         -7.0190E-10  8.1930E-06  1.5350E-06 -1.3800E-05 -5.3820E-09
     0.          0.          0.          0.          0.          0.          0.          0.
    -3.4520E-07  8.1070E-09  1.1220E-09 -7.1230E-07 -2.5980E-07 -6.0140E-06 -1.3600E-07 -3.9320E-06
     7.1960E-09  5.0830E-06  1.0100E-05  0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 6   0.          0.          0.         -1.6840E-09  1.5350E-06  5.6910E-06 -9.3740E-06 -1.2000E-08
     0.          0.          0.          0.          0.          0.          0.          0.
     2.5390E-06 -3.4670E-08  1.5650E-08 -1.4760E-05  7.2950E-06 -3.5500E-06 -2.1970E-07 -3.1700E-06
     7.2670E-08  3.8660E-06  7.2860E-06  0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 7   0.          0.          0.         -1.6690E-10 -1.3880E-05 -9.3740E-06  1.7910E-04 -9.7170E-10
     0.          0.          0.          0.          0.          0.          0.          0.
    -3.2950E-06  2.5290E-08 -3.6280E-09  2.7260E-06 -1.1970E-06 -3.0010E-06 -3.3350E-08  1.1880E-05
    -1.9610E-08 -8.3600E-05 -1.2470E-04  0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 8   0.          0.          0.          1.2010E-05 -5.3820E-09 -1.2400E-08 -9.7170E-10  1.0990E-04
     0.          0.          0.          0.          0.          0.          0.          0.
     4.3310E-09 -7.9730E-07 -5.1900E-06 -1.9990E-08  9.2900E-09 -9.6300E-09 -2.1160E-07 -2.9090E-09
    -1.4020E-06 -9.2290E-11  1.6770E-08  0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
 9   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
10   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
11   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
12   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
13   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
14   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
15   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
16   0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.          0.          0.
     0.          0.          0.          0.          0.          0.
```

Matrix Q (cont'd):

17	0.	0.	0.	-4.9230E-10	-3.4520E-07	8.5390E-06	-3.2950E-06	4.3310E-09
	0.	0.	0.	0.	0.	0.	0.	0.
	8.0140E-06	-2.3560E-08	8.7860E-09	-8.0750E-06	4.5690E-06	3.8910E-06	6.7720E-10	8.0330E-07
	4.0600E-04	1.7230E-06	8.3850E-06	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
18	0.	0.	0.	-3.8200E-07	8.1070E-09	-3.4670E-08	2.5290E-08	-7.9730E-07
	0.	0.	0.	0.	0.	0.	0.	0.
	-2.3560E-08	1.3500E-07	3.7970E-07	1.0640E-07	-5.7790E-08	-2.6850E-08	-3.4940E-06	-3.7460E-09
	2.2120E-06	-1.3040E-08	-1.8880E-08	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
19	0.	0.	0.	-1.2370E-06	1.1220E-09	1.8650E-08	-3.6240E-09	-5.1980E-06
	0.	0.	0.	0.	0.	0.	0.	0.
	8.7460E-09	3.7970E-07	1.1150E-06	-4.1950E-08	2.2430E-08	5.2370E-09	-9.5440E-06	-6.3530E-09
	6.0610E-06	-6.1870E-10	5.4200E-09	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
20	0.	0.	0.	-3.7370E-10	-7.1230E-07	-1.4760E-05	2.7240E-06	-1.9990E-08
	0.	0.	0.	0.	0.	0.	0.	0.
	-8.0750E-06	1.0660E-07	-4.1930E-04	4.2470E-05	-2.2030E-05	3.4170E-07	3.9660E-07	3.2990E-06
	-1.9510E-07	-6.0670E-07	-3.4120E-06	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
21	0.	0.	0.	-7.3630E-10	-2.5980E-07	7.2950E-06	-1.1970E-06	9.2900E-09
	0.	0.	0.	0.	0.	0.	0.	0.
	4.5690E-06	-5.7790E-08	2.2830E-08	-2.2830E-05	1.1760E-05	3.2620E-06	-1.4310E-07	-2.7740E-07
	1.0640E-07	4.8600E-07	1.3930E-06	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
22	0.	0.	0.	-4.5310E-09	-6.0140E-06	-3.5500E-06	-3.0010E-06	-9.6300E-09
	0.	0.	0.	0.	0.	0.	0.	0.
	3.8910E-06	-2.6850E-08	5.2370E-09	3.4170E-07	3.2620E-06	3.5140E-05	6.9430E-07	1.4290E-05
	1.9410E-04	4.1860E-06	-2.2560E-07	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
23	0.	0.	0.	8.7910E-06	-1.3600E-07	-2.1570E-07	-3.3350E-08	-2.1160E-07
	0.	0.	0.	0.	0.	0.	0.	0.
	6.7720E-10	-3.4940E-06	-9.5440E-06	3.9660E-07	-1.4310E-07	6.9430E-07	9.3140E-05	3.6280E-07
	-5.4720E-05	9.6750E-08	-5.7150E-08	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
24	0.	0.	0.	3.1030E-09	-3.5320E-06	-3.1700E-06	1.1480E-05	-2.9090E-09
	0.	0.	0.	0.	0.	0.	0.	0.
	8.0330E-07	-3.7460E-09	-6.3530E-09	3.2990E-06	-2.7740E-07	1.4290E-05	3.6280E-07	6.9820E-06
	-3.9360E-08	-4.3560E-06	-9.3370E-06	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
25	0.	0.	0.	-5.6420E-06	7.1960E-09	7.2670E-08	-1.9610E-04	-1.4020E-06
	0.	0.	0.	0.	0.	0.	0.	0.
	4.0600E-08	2.2120E-06	6.0610E-06	-1.9510E-07	1.0640E-07	1.9410E-04	-5.8720E-05	-3.9360E-08
	3.7040E-05	-5.0490E-09	3.2330E-08	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
26	0.	0.	0.	1.6660E-09	5.9830E-06	3.8660E-06	-8.3640E-05	-9.2290E-11
	0.	0.	0.	0.	0.	0.	0.	0.
	1.7230E-06	-1.3040E-08	-6.1470E-10	-6.0670E-07	4.8600E-07	4.1860E-06	9.6750E-08	-4.3560E-06
	-5.0490E-09	3.9300E-05	5.8060E-05	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
27	0.	0.	0.	-6.0460E-10	1.0100E-05	7.2460E-06	-1.2470E-04	1.6770E-08
	0.	0.	0.	0.	0.	0.	0.	0.
	2.3250E-06	-1.4840E-08	5.4200E-09	-3.4120E-06	1.3930E-06	-2.2560E-07	-5.7150E-08	-9.3370E-06
	3.2330E-08	5.8060E-05	8.7090E-05	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
28	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
29	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		

Matrix Q (cont'd) :

30	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
31	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
32	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
33	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
34	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
35	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
36	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
37	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		
38	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.		

SPAR

Matrix F :

CONTROL MATRIX F PRODUCED BY RICQ PROGRAM $(u = -F X_c)$

ROW 1	-1.0911E-02	1.0142E-06	1.4355E-05	-1.5898E-01	-1.3373E-01	2.0568E+00	2.4684E-06	-5.7665E-01
	2.0814E-04	7.6859E-04	-1.7109E+00	-1.9022E+00	2.4327E+01	-5.1360E-05	-1.5629E-03	9.6771E-06
	-2.3846E-03	2.4955E-02	-1.9847E-01	1.5869E-05	-1.1739E-01	3.2390E-02		
ROW 2	-6.1942E-06	-1.7173E-02	1.3253E-01	-5.2947E-05	-1.7687E-04	-1.1805E-05	2.1006E+00	-1.2244E-0
	-4.5245E-01	1.5594E+00	-5.8406E-04	-2.2198E-03	-1.8541E-04	2.4578E+01	-6.6736E-05	3.4499E-02
	-1.2131E-04	4.0130E-05	1.3793E-05	-1.0559E-01	2.8195E-04	4.6870E-05		
ROW 3	1.7700E-01	-3.0192E-01	1.3302E-01	3.6544E-01	7.6142E-01	5.8150E-02	-5.1424E-02	2.9450E+0
	-7.8703E+00	3.9120E+00	1.6605E+01	2.2577E+01	4.1136E-01	-3.2951E-01	4.9373E-02	8.9640E-0
	6.1529E-01	-9.2181E-03	5.6634E-01	-2.9508E-02	1.1735E+00	-2.0915E-01		
ROW 4	4.4736E-01	3.0181E-01	-1.3302E-01	2.0528E-02	-4.0067E-01	1.7695E-02	5.1481E-02	1.7163E+01
	7.8668E+00	-3.9068E+00	-1.9290E+00	-1.7688E+01	1.6221E-01	3.3029E-01	-3.9505E-02	-9.1066E-0
	-9.3235E-01	1.3402E-01	5.5849E-01	2.9721E-02	3.1235E-02	7.9669E-03		
ROW 5	-4.4789E-01	3.0074E-01	-1.3202E-01	-1.9566E-02	4.0707E-01	-1.7631E-02	5.1404E-02	-1.7184E+0
	7.6324E+00	-3.6698E+00	1.9545E+00	1.7744E+01	-1.6167E-01	3.2881E-01	3.9300E-02	-9.0191E-03
	9.5594E-01	-1.3452E-01	-3.4188E-01	2.9845E-02	-2.3815E-02	-7.4715E-03		
ROW 6	-1.7661E-01	-3.0063E-01	1.3202E-01	-3.6621E-01	-7.6292E-01	-5.8254E-02	-5.1356E-02	-2.9301E+
	-7.8310E+00	3.6646E+00	-1.6632E+01	-2.2612E+01	-4.1182E-01	-3.2944E-01	-4.9301E-02	9.1621E-0
	-6.1869E-01	9.6595E-03	-5.6227E-01	-3.0057E-02	-1.1777E+00	2.0902E-01		
ROW 7	2.6644E-02	-6.7695E-02	-1.4204E-01	-6.1458E-02	9.4464E-02	2.7733E-02	3.0656E-02	1.3038E+00
	-1.5255E+00	-3.7036E+00	-3.5976E+00	1.8601E+00	1.6551E-01	3.2059E-02	-6.4465E-02	3.6415E-0
	6.6960E-02	-2.1219E-01	-6.4232E-01	-6.9259E-01	4.8961E-01	-3.6154E-01		
ROW 8	2.6987E-02	6.7886E-02	1.4239E-01	-6.2193E-02	9.4042E-02	2.7843E-02	-3.0779E-02	1.3145E+0
	1.5271E+00	3.7051E+00	-3.6186E+00	1.8367E+00	1.6662E-01	-3.2233E-02	-6.2559E-02	-3.7131E-03
	6.5534E-02	-2.1233E-01	-6.2218E-01	6.9403E-01	4.0518E-01	-3.6423E-01		
ROW 9	-2.6649E-02	6.7695E-02	1.4204E-01	6.1458E-02	-9.4464E-02	-2.7733E-02	-3.0656E-02	-1.3038E+0
	1.5255E+00	3.7036E+00	3.5976E+00	-1.8601E+00	-1.6551E-01	-3.2059E-02	6.4465E-02	-3.6415E-0
	-6.8960E-02	2.1219E-01	6.4232E-01	6.9259E-01	-4.8961E-01	3.6154E-01		
ROW 10	-2.6987E-02	-6.7886E-02	-1.4239E-01	6.2193E-02	-9.4042E-02	-2.7843E-02	3.0779E-02	-1.3145E+00
	-1.5271E+00	-3.7051E+00	3.6186E+00	-1.8367E+00	-1.6662E-01	3.2233E-02	6.2559E-02	3.7131E-0
	-6.5534E-02	2.1233E-01	6.2218E-01	-6.9403E-01	-4.0518E-01	3.6423E-01		

CONTROL PERIOD = 10 SECS. DYNACON MODAL WEIGHTING MATRIX. $R = DIAG(10^{-6})$, $R_R = DIAG(10^{-}$

(-F) STORED IN FILE RICMATF.

Eigenvalues of $(\tilde{A}_c - \tilde{B}_c F)$:

ORDER	MAGNITUDE	PHASE (DEGREES)
4	0.7074E+00	0.1353E+03
	0.7074E+00	-0.1353E+03
1	0.9324E+00	0.7793E+02
	0.9324E+00	-0.7793E+02
9	0.3742E+00	0.1800E+03
	0.4567E+00	0.1800E+03
2	0.8003E+00	0.4464E+02
	0.8003E+00	-0.4464E+02
10	0.2662E+00	0.6473E+02
	0.2662E+00	-0.6473E+02
3	0.7350E+00	0.1468E+02
	0.7350E+00	-0.1468E+02
5	0.6494E+00	0.8343E+01
	0.6494E+00	-0.8343E+01
7	0.6430E+00	0.2305E+02
	0.6430E+00	-0.2305E+02
6	0.6730E+00	0.2189E+02
	0.6730E+00	-0.2189E+02
8	0.5957E+00	0.2565E+02
	0.5957E+00	-0.2565E+02
11	0.7116E+01	0.1800E+03
12	0.5426E+01	0.1800E+03

State Weighting Matrix

Matrix $\bar{Q}$:

$\bar{Q}$ MATRIX PRODUCED BY CONS2 PROGRAM.

MATRIX QBAR (22 BY 22

	1.0000E-05,	0. ,	0. ,	0. ,	0. ,
ROW 1	0. ,	0. ,	5.0000E-05,	0. ,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,			
	0. ,	1.0000E-05,	0. ,	0. ,	0. ,
	0. ,	0. ,	0. ,	5.0000E-05,	0. ,
ROW 2	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,			
	0. ,	0. ,	1.6540E-05,	-7.0190E-09,	-1.6840E-08,
	-1.6690E-09,	1.2810E-04,	0. ,	0. ,	8.2700E-05,
ROW 3	-3.5095E-08,	-8.4200E-08,	-8.3450E-09,	6.4050E-04,	-3.7640E-09,
	-3.5737E-06,	7.2936E-10,	-5.5032E-09,	-2.0984E-08,	-3.7020E-05,
	-3.9324E-10,	-6.8484E-09,			
	0. ,	0. ,	-7.0190E-09,	2.1930E-05,	1.5350E-05,
	-1.3880E-04,	-5.3420E-08,	0. ,	0. ,	-3.5095E-08,
ROW 4	1.0965E-04,	7.6750E-05,	-6.9400E-04,	-2.6710E-07,	-2.6509E-06,
	3.0554E-09,	7.7970E-07,	-6.6778E-06,	-1.4879E-05,	3.3824E-08,
	-5.5182E-07,	-9.1555E-06,			
	0. ,	0. ,	-1.6840E-08,	1.5350E-05,	5.8910E-05,
	-9.3740E-05,	-1.2440E-07,	0. ,	0. ,	-8.4200E-08,
ROW 5	7.6750E-05,	2.9455E-04,	-4.6870E-04,	-6.2200E-07,	1.9404E-05,
	4.5872E-08,	1.5622E-05,	-3.6060E-06,	1.1014E-04,	4.6618E-07,
	-1.4995E-05,	-5.0231E-06,			
	0. ,	0. ,	-1.6690E-09,	-1.3880E-04,	-9.3740E-05,
	1.7910E-03,	-9.7170E-09,	0. ,	0. ,	-8.3450E-09,
ROW 6	-6.9400E-04,	-4.6870E-04,	8.9550E-03,	-4.8585E-08,	-2.5147E-05,
	-1.0856E-08,	-2.6766E-06,	-3.7561E-06,	-1.4348E-04,	-1.0724E-07,
	2.7479E-06,	-4.5600E-06,			
	0. ,	0. ,	1.2810E-04,	-5.3420E-08,	-1.2440E-07,
	-9.7170E-09,	1.9990E-03,	0. ,	0. ,	6.4050E-04,
ROW 7	-2.6710E-07,	-6.2200E-07,	-4.8585E-08,	9.9950E-03,	3.3003E-08,
	-1.5017E-05,	2.2339E-08,	-1.1925E-08,	1.8972E-07,	-1.5556E-04,
	-2.0666E-08,	-1.4009E-08,			
	5.0000E-05,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,	3.3333E-04,	0. ,	0. ,
ROW 8	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,			
	0. ,	5.0000E-05,	0. ,	0. ,	0. ,
ROW 9	0. ,	0. ,	0. ,	3.3333E-04,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,	0. ,	0. ,	0. ,
	0. ,	0. ,			
	0. ,	0. ,	8.2700E-05,	-3.5095E-08,	-8.4200E-08,
	-8.3450E-09,	6.4050E-04,	0. ,	0. ,	5.5133E-04,
ROW 10	-2.3397E-07,	-5.6133E-07,	-5.5633E-08,	4.2700E-03,	-1.6146E-08,
	1.8058E-06,	6.4504E-09,	-4.3493E-08,	-1.3618E-07,	-2.1688E-04,
	1.0500E-08,	-2.9948E-09,			
	0. ,	0. ,	-3.5095E-08,	1.0965E-04,	7.6750E-05,
	-6.9400E-04,	-2.6710E-07,	0. ,	0. ,	-2.3397E-07,
ROW 11	7.3100E-04,	5.1167E-04,	-4.6267E-03,	-1.7807E-06,	-1.1292E-05,
	-2.7932E-09,	8.2944E-06,	-5.3863E-05,	-9.6978E-05,	1.9593E-07,
	2.0019E-05,	-3.5994E-06,			

Matrix $\bar{Q}$ (cont'd) :

Row					
ROW 12	0.	0.	-8.4200E-08,	7.6750E-05,	2.0455E-04,
	-4.6870E-04,	-6.2200E-07,	0.	0.	-5.6133E-07,
	5.1167E-04,	1.9637E-03,	-3.1247E-03,	-4.1467E-06,	8.2463E-05,
	-1.8048E-08,	1.8066E-04,	-3.2504E-05,	7.1427E-04,	2.7335E-06,
	3.7748E-04,	2.2409E-06,			
ROW 13	0.	0.	-8.3450E-09,	-6.9400E-04,	-4.6870E-04,
	8.9550E-03,	-4.8585E-08,	0.	0.	-5.5633E-08,
	-4.6267E-03,	-3.1247E-03,	5.9700E-02,	-3.2390E-07,	-1.0675E-04,
	2.6279E-09,	-3.2224E-05,	-2.9094E-05,	-9.3021E-04,	-6.2927E-07,
	-6.9193E-05,	-2.4076E-06,			
ROW 14	0.	0.	6.4050E-04,	-2.6710E-07,	-6.2200E-07,
	-4.8585E-08,	9.9950E-03,	0.	0.	4.2700E-03,
	-1.7807E-06,	-4.1467E-06,	-3.2390E-07,	6.6633E-02,	1.3993E-07,
	7.5880E-06,	2.5240E-07,	-9.7466E-08,	1.2306E-06,	-9.1134E-04,
	5.1148E-07,	-1.2787E-09,			
ROW 15	0.	0.	-3.7840E-09,	-2.6509E-06,	1.9408E-05,
	-2.5147E-05,	3.3003E-08,	0.	0.	-1.6146E-08,
	-1.1292E-05,	8.2463E-05,	-1.0675E-04,	1.3993E-07,	1.2613E-05,
	2.9533E-08,	4.6573E-06,	1.0640E-06,	5.8045E-05,	1.8620E-07,
	-2.4870E-05,	5.6591E-06,			
ROW 16	0.	0.	-3.5737E-06,	3.0554E-09,	4.5872E-08,
	-1.0856E-08,	-1.5017E-05,	0.	0.	1.8098E-06,
	-2.7932E-09,	-1.8048E-08,	2.6279E-09,	7.5880E-06,	2.9533E-08,
	4.3832E-06,	-2.7524E-08,	-2.0281E-09,	6.6849E-09,	4.7220E-06,
	-2.7525E-07,	6.8956E-09,			
ROW 17	0.	0.	7.2036E-10,	7.7970E-07,	1.5622E-05,
	-2.6766E-06,	2.2339E-08,	0.	0.	6.4504E-09,
	0.2944E-06,	1.8066E-04,	-3.2224E-05,	2.5240E-07,	4.6573E-06,
	-2.7520E-08,	1.7976E-04,	3.3367E-06,	9.2437E-05,	3.9994E-07,
	3.6559E-05,	3.3644E-06,			
ROW 18	0.	0.	-5.5032E-09,	-6.6778E-06,	-3.6060E-06,
	-3.7561E-06,	-1.1925E-08,	0.	0.	-4.3493E-08,
	-5.3063E-05,	-3.2504E-05,	-2.9094E-05,	-9.7466E-08,	1.0640E-06,
	-2.0281E-09,	3.3367E-06,	1.4615E-04,	2.5843E-05,	1.4850E-08,
	-7.1476E-06,	2.8740E-05,			
ROW 19	0.	0.	-2.0904E-08,	-1.4879E-05,	1.1014E-04,
	-1.4348E-04,	1.0972E-07,	0.	0.	-1.3618E-07,
	-9.6978E-05,	7.1427E-04,	-9.3021E-04,	1.2306E-06,	5.8045E-05,
	6.6849E-09,	9.2437E-05,	2.5843E-05,	4.8062E-04,	1.3186E-06,
	1.4860E-04,	8.8677E-07,			
ROW 20	0.	0.	-3.7020E-05,	3.3824E-08,	4.6618E-07,
	-1.0724E-07,	-1.5550E-04,	0.	0.	-2.1608E-04,
	1.9503E-07,	2.7335E-06,	-6.2927E-07,	-9.1134E-04,	1.8620E-07,
	4.7220E-06,	3.9994E-07,	1.4850E-08,	1.3186E-06,	1.1895E-04,
	1.6715E-07,	-2.9431E-09,			
ROW 21	0.	0.	-3.9324E-10,	-5.5182E-07,	-1.4995E-05,
	2.7479E-06,	-2.0666E-08,	0.	0.	1.0500E-08,
	2.0019E-05,	3.7748E-04,	-6.9193E-05,	5.1148E-07,	-2.4870E-05,
	-2.7525E-07,	3.6559E-05,	-7.1476E-06,	1.4860E-04,	1.6715E-07,
	6.8155E-04,	7.2173E-06,			
ROW 22	0.	0.	-6.8484E-09,	-9.1555E-06,	-5.0231E-06,
	-4.5600E-06,	-1.4009E-08,	0.	0.	-2.9948E-09,
	-3.5994E-06,	2.2409E-06,	-2.4076E-06,	-1.2787E-09,	5.6591E-06,
	6.8956E-09,	3.3644E-06,	2.8740E-05,	8.8677E-07,	-2.9431E-09,
	7.2173E-06,	2.3383E-08,			

SPAR

Matrix $\bar{F}$:

CONTROL MATRIX F PRODUCED BY RICQ PROGRAM ($u = -F x_i$)

ROW 1	-1.8257E-02	-8.2767E-06	-5.3552E-06	-1.0584E-01	-9.4367E-02	1.5299E+00	-8.2735E-06	-4.9009E-0[illegible]
	-8.0934E-05	1.0876E-04	-1.4935E+00	-1.5233E+00	2.1019E+01	-7.9719E-05	5.2649E-03	2.7710E-0[illegible]
	2.4920E-03	2.2058E-02	-1.6015E-01	1.9224E-04	-3.7568E-02	4.2070E-02		
ROW 2	-7.9777E-06	-3.2186E-02	7.2925E-02	4.0977E-06	-6.3499E-05	-3.0710E-05	1.3369E+00	-1.0910[illegible]06
	-6.1559E-01	1.1202E+00	-8.2575E-05	-1.0080E-03	-4.0226E-04	2.1094E+01	-1.5097E-04	2.0095[illegible]02
	6.5827E-05	8.5447E-05	-1.8482E-03	-1.8973E-02	2.1728E-04	4.2078E-04		
ROW 3	5.6699E-01	-6.3369E-01	2.4926E-01	3.4786E-01	1.2266E+00	7.5108E-02	-6.0445E-02	1.0971[illegible]01
	-1.2100E+01	4.8097E+00	1.4108E+01	2.3893E+01	5.3308E-01	-3.5669E-01	2.6644E-01	5.9180[illegible]02
	8.1631E-01	-2.3340E-01	3.1728E+00	3.3282E-01	-5.3864E-01	-5.5688E-01		
ROW 4	9.2942E-01	6.3354E-01	-2.4937E-01	1.9479E-01	-7.3463E-01	5.8604E-02	6.0586E-02	2.0170E-01
	1.2100E+01	-4.8048E+00	5.4810E-01	-2.1391E+01	3.0358E-01	3.5725E-01	1.4025E-01	-5.9316E-02
	-2.1667E+00	3.4797E-01	3.7054E-01	-3.3797E-01	1.4521E+00	2.0078E-01		
ROW 5	-9.3029E-01	6.3069E-01	-2.4738E-01	-1.9329E-01	7.3876E-01	-5.8747E-02	6.0623E-02	-2.0196[illegible]01
	1.2042E+01	-4.7562E+00	-5.1312E-01	2.1868E+01	-3.0390E-01	3.6019E-01	-1.4380E-01	-6.1802E-02
	2.1722E+00	-3.4760E-01	-3.8053E-01	-3.3982E-01	-1.4385E+00	-1.9625E-01		
ROW 6	-5.6712E-01	-6.3055E-01	2.4750E-01	-5.4795E-01	-1.2283E+00	-7.5049E-02	-6.0766E-02	-1.0981[illegible]01
	-1.2042E+01	4.7514E+00	-1.4092E+01	-2.3898E+01	-5.3310E-01	-3.6076E-01	-2.6393E-01	6.1930[illegible]02
	-8.1867E-01	2.3247E-01	-3.1659E+00	3.4497E-01	5.4407E-01	5.5456E-01		
ROW 7	2.9668E-02	-7.6931E-02	-2.1110E-01	-8.3119E-02	9.7909E-02	5.8793E-03	1.7501E-02	1.6300E+00
	-1.4564E+00	-4.0169E+00	-4.0240E+00	1.6932E+00	1.5750E-02	-5.4439E-03	-5.5552E-02	-1.9052E-02
	-3.2756E-02	-2.1422E-01	-8.7595E-01	-9.8764E-01	4.2162E-01	-3.2698E-01		
ROW 8	2.9983E-02	7.7177E-02	2.1186E-01	-8.4397E-02	9.5731E-02	6.2421E-03	-1.7703E-02	1.6400[illegible]00
	1.4587E+00	4.0227E+00	-4.0455E+00	1.6548E+00	1.9593E-02	4.3680E-03	-5.2249E-02	1.9195E-02
	-3.6356E-02	-2.1567E-01	-8.3697E-01	9.9057E-01	4.1732E-01	-3.3579E-01		
ROW 9	-2.9668E-02	7.6931E-02	2.1110E-01	8.3119E-02	-9.7909E-02	-5.8793E-03	-1.7501E-02	-1.6300[illegible]00
	1.4564E+00	4.0169E+00	4.0240E+00	-1.6932E+00	-1.5750E-02	5.4439E-03	5.5552E-02	1.9052[illegible]02
	3.2756E-02	2.1422E-01	8.7595E-01	9.8764E-01	-4.2162E-01	3.2698E-01		
ROW 10	-2.9983E-02	-7.7177E-02	-2.1186E-01	8.4397E-02	-9.5731E-02	-6.2421E-03	1.7703E-02	-1.6400E+00
	-1.4587E+00	-4.0227E+00	4.0455E+00	-1.6548E+00	-1.9593E-02	-4.3680E-03	5.2249E-02	-1.9195[illegible]02
	3.6356E-02	2.1567E-01	8.3697E-01	-9.9057E-01	-4.1732E-01	3.3579E-01		

CONTROL PERIOD = 10 secs. $\bar{Q}$ MODAL WEIGHTING MATRIX. $R = DIAG(10^{-6})$, $R_a = DIAG(10^{-6})$

$(-F)$ STORED IN FILE RICQF.

Eigenvalues of $(\bar{A}_c - \bar{B}_c \bar{F})$:

ORDER	MAGNITUDE	PHASE (DEGREES)
1	0.8972E+00	0.7120E+02
	0.8972E+00	-0.7120E+02
2	0.7481E+00	0.2067E+02
	0.7481E+00	-0.2067E+02
7	0.3363E+00	0.1607E+03
	0.3363E+00	-0.1607E+03
3	0.6260E+00	0.3158E+02
	0.6260E+00	-0.3158E+02
4	0.5568E+00	0.2792E+02
	0.5568E+00	-0.2792E+02
5	0.4578E+00	0.4895E+02
	0.4578E+00	-0.4895E+02
8	0.2803E+00	0.2847E+02
	0.2803E+00	-0.2847E+02
6	0.0348E+00	0.2889E+02
	0.0348E+00	-0.2889E+02
9	0.1220E+00	0.2657E+02
	0.1220E+00	-0.2657E+02
12	0.1688E-01	0.
11	0.5262E-01	0.
13	0.1518E-01	0.
10	0.5776E-01	0.

Observer System Matrix

Matrix A_0 :

OBSERVER A_0 ARRAY ($A_0 = A_c - K_0 C_c$)

Row 1	-5.40000000E-01	1.00000000E+00	0.
	0.	0.	0.
	-2.04541023E-01	0.	-1.00776457E-01
	0.	-4.20275062E-02	0.
	-1.05460490E-05	0.	-9.79512485E-02
	-6.37598098E-05	-4.94732061E-02	1.17535077E-01
	0.	0.	0.
	0.		
Row 2	-9.00086400E-02	0.	0.
	0.	0.	0.
	-4.07607490E-02	0.	-1.67976005E-02
	0.	-7.13861620E-03	0.
	-3.09183825E-06	0.	-1.63267753E-02
	-1.06276551E-05	-8.24633250E-03	1.95910601E-02
	0.	0.	0.
	0.		
Row 3	0.	0.	-5.40000000E-01
	1.00000000E+00	2.12372170E-01	0.
	-9.01177170E-05	0.	-1.01835910E-03
	0.	-7.91058264E-05	0.
	-2.99793103E-02	0.	-1.73140309E-04
	-1.25850178E-01	2.66115339E-03	-2.17027340E-04
	0.	0.	0.
	0.		
Row 4	0.	0.	-9.00086400E-02
	0.	3.53987606E-02	0.
	-1.50210614E-05	0.	-1.69742810E-04
	0.	-1.31855701E-05	0.
	-4.99703139E-03	0.	-2.88594868E-05
	-2.09770433E-02	4.43568143E-04	-3.61746972E-05
	0.	0.	0.
	0.		
Row 5	0.	0.	0.
	0.	-5.40000000E-01	1.00000000E+00
	2.29146690E-04	0.	5.49670909E-04
	0.	5.04730305E-05	0.
	2.79560150E-02	0.	4.91703594E-04
	5.87187570E-01	-5.26045744E-04	2.57055201E-03
	0.	0.	0.
	0.		
Row 6	0.	0.	0.
	0.	-9.00086400E-02	0.
	3.81947814E-05	0.	9.16219464E-05
	0.	9.08004468E-06	0.
	4.65978312E-03	0.	8.19718000E-05
	9.78673227E-02	-8.76827075E-05	4.20464464E-04
	0.	0.	0.
	0.		

Matrix A_0 (cont'd):

	0.,	0.,	0.,
	0.,	0.,	0.,
	-5.40000000E-01,	1.00000000E+00,	-3.70103152E-01,
Row 7	0.,	-6.20000760E-02,	0.,
	-5.77134670E-05,	0.,	3.02020653E-01,
	-1.10011461E-04,	2.04406991E-01,	3.05226361E+00,
	0.,	0.,	0.,
	0.,		
	0.,	0.,	0.,
	0.,	0.,	0.,
	-9.00086400E-02,	0.,	-6.30232416E-02,
	0.,	-1.00021000E-02,	0.,
Row 8	-9.61983459E-06,	0.,	5.03429413E-02,
	-1.83370037E-05,	3.40777697E-02,	5.08759438E-01,
	0.,	0.,	0.,
	0.,		
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	0.,	-5.40000000E-01,
	1.00000000E+00,	-3.00487269E-02,	0.,
Row 9	-5.96615077E-05,	0.,	-3.11922117E-01,
	-1.56680967E-03,	1.59924110E+00,	-7.40309536E-02,
	0.,	0.,	0.,
	0.,		
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	0.,	-9.00086400E-02,
Row 10	0.,	-6.47540940E-03,	0.,
	-9.94453021E-06,	0.,	-5.19920102E-02,
	-2.61173340E-04,	2.66569770E-01,	-1.23396760E-02,
	0.,	0.,	0.,
	0.,		
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	-5.40000000E-01,	1.00000000E+00,
Row 11	-5.28101959E-06,	0.,	4.31828917E-02,
	1.16647865E-04,	-6.62402074E-02,	-3.76226959E-01,
	0.,	0.,	0.,
	0.,		
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	0.,	0.,
	0.,	-9.00086400E-02,	0.,
Row 12	-8.80254427E-07,	0.,	7.19783954E-03,
	1.94431106E-05,	-1.16410940E-02,	-6.27105127E-02,
	0.,	0.,	0.,
	0.,		

Matrix A_0 (cont'd):

	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 13	0.	0.	0.
	-5.40000000E-01	1.00000000E+00	1.71573472E-04
	2.01066320E-01	-1.35050510E-04	1.00972692E-04
	0.	0.	0.
	0.		
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 14	-9.00006400E-02	0.	2.05983230E-05
	3.35102700E-02	-2.25119130E-05	3.14904722E-05
	0.	0.	0.
	0.		
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 15	0.	0.	-3.73369059E-02
	-7.94320120E-03	1.19053900E-01	6.02716359E-01
	1.00000000E+00	0.	0.
	0.		
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 16	0.	0.	0.
	0.	0.	-8.50925255E-01
	-1.07685017E-01	2.74196213E+00	1.30300563E+01
	0.	1.00000000E+00	0.
	0.		
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 17	0.	0.	0.
	0.	0.	2.50061272E-01
	5.58105210E-02	-8.33032000E-01	-4.19974493E+00
	0.	0.	1.00000000E+00
	0.		
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
Row 18	0.	0.	6.31907491E-02
	1.36485363E-02	-2.04562967E-01	-1.03743209E+00
	0.	0.	0.
	1.00000000E+00		

SPAR

Matrix A_0 (cont'd):

Row 19	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	7.23523774E-05
	2.02673703E-03	-5.03016070E-02	-2.55906263E-01
	-1.04609310E-03	0.	0.
	0.		
Row 20	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	1.05930888E-01
	-3.24758256E-02	-3.40000023E-01	-1.71033330E+00
	0.	-3.40091023E-03	0.
	0.		
Row 21	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	-2.06454564E-01
	-4.40594041E-02	3.56359905E-01	3.36014019E+00
	0.	0.	-1.71116506E-02
	0.		
Row 22	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	1.02707532E-01
	2.22539784E-02	-3.31305530E-01	-2.28213144E+00
	0.	0.	0.
	-4.21471033E-02		

Matrix K_0 :

OBSERVER K_0 MATRIX

Row 1	3.21006373E+01	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 2	5.35120696E+00	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 3	0.	3.21006373E+01	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 4	0.	5.35120696E+00	0.
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 5	0.	0.	5.03790109E+02
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 6	0.	0.	9.09750922E+01
	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 7	0.	0.	0.
	5.15759312E+02	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 8	0.	0.	0.
	0.59681375E+01	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 9	0.	0.	0.
	0.	2.69595607E+02	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 10	0.	0.	0.
	0.	4.49569140E+01	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 11	0.	0.	0.
	0.	0.	7.77640770E+01
	0.	0.	0.
	0.	0.	0.
	0.		

Matrix K_o (cont'd):

Row 12	0.	0.	0.
	0.	0.	1.29620737E+01
	0.	0.	0.
	0.	0.	0.
	0.		
Row 13	0.	0.	0.
	0.	0.	0.
	7.00234070E+01	0.	0.
	0.	0.	0.
	0.		
Row 14	0.	0.	0.
	0.	0.	0.
	1.30051099E+01	0.	0.
	0.	0.	0.
	0.		
Row 15	0.	0.	0.
	0.	0.	0.
	0.	2.42155529E+00	3.98899648E-01
	2.19766290E+00	-4.05200916E+01	-0.75108186E+00
	6.70527764E+01		
Row 16	0.	0.	0.
	0.	0.	0.
	0.	5.25533102E+01	9.63696077E+00
	5.34397060E+01	-9.07230039E+02	-1.22553495E+02
	1.46622325E+03		
Row 17	0.	0.	0.
	0.	0.	0.
	0.	-1.62444492E+01	-2.02336400E+00
	-1.55051706E+01	2.07532058E+02	0.47057762E+01
	-4.52086026E+02		
Row 18	0.	0.	0.
	0.	0.	0.
	0.	-3.65086996E+00	-6.86672176E-01
	-3.78109670E+00	6.97167465E+01	1.74795630E+00
	-1.02965534E+02		
Row 19	0.	0.	0.
	0.	0.	0.
	0.	-8.72360002E-01	-1.22110636E-01
	-6.36607115E-01	1.15500510E+01	-3.03002611E-01
	-2.47213216E+01		
Row 20	0.	0.	0.
	0.	0.	0.
	0.	-6.86249180E+00	-1.33052999E+00
	-7.52924752E+00	1.39647391E+02	2.45970149E+01
	-1.90055112E+02		
Row 21	0.	0.	0.
	0.	0.	0.
	0.	1.24767909E+01	2.20616035E+00
	1.21354598E+01	-2.24672429E+02	-2.46624121E+01
	3.51652924E+02		
Row 22	0.	0.	0.
	0.	0.	0.
	0.	-6.24870047E+00	-1.12665356E+00
	-6.21906487E+00	1.14741192E+02	1.17450751E+01
	-1.74519207E+02		

Matrix B_0 :

Row 1	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 2	0.	0.	8.41000000E-03
	8.41000000E-03	-8.41000000E-03	-8.41000000E-03
	8.41000000E-03	8.41000000E-03	-8.41000000E-03
	-8.41000000E-03		
Row 3	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 4	0.	0.	-1.45700000E-02
	1.45700000E-02	1.45700000E-02	-1.45700000E-02
	-1.45700000E-02	1.45700000E-02	1.45700000E-02
	-1.45700000E-02		
Row 5	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 6	0.	0.	5.72900000E-03
	-5.72900000E-03	-5.72900000E-03	5.72900000E-03
	-2.66900000E-02	2.66900000E-02	2.66900000E-02
	-2.66900000E-02		
Row 7	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 8	0.	0.	3.80600000E-03
	3.81100000E-03	-3.80600000E-03	-3.81100000E-03
	-1.90600000E-02	-1.90800000E-02	1.90600000E-02
	1.90600000E-02		
Row 9	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 10	0.	0.	1.02200000E-02
	-7.07800000E-03	7.13300000E-03	-1.02700000E-02
	9.29900000E-03	9.28400000E-03	-9.29900000E-03
	-9.28400000E-03		
Row 11	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 12	6.94400000E-03	0.	1.28900000E-03
	4.53900000E-05	-4.11200000E-05	-1.29300000E-03
	-2.67500000E-00	-2.70200000E-04	2.67500000E-04
	2.70200000E-04		

Matrix B_o (cont'd) :

Row			
Row 13	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 14	6.79100000E-08,	6.92100000E-03,	-8.07500000E-04,
	8.08100000E-04,	8.09400000E-04,	-8.10000000E-04,
	9.73500000E-04,	-9.72500000E-04,	-9.73500000E-08,
	9.72500000E-04,		
Row 15	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 16	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 17	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 18	0.	0.	0.
	0.	0.	0.
	0.	0.	0.
	0.		
Row 19	-5.55300000E-04,	-2.19900000E-06,	6.53000000E-03,
	-3.47000000E-03,	3.48800000E-03,	-6.53900000E-03,
	-4.82600000E-02,	-4.78300000F-02,	4.82600000E-02,
	4.78300000E-02,		
Row 20	-1.50000000E-06,	-2.57700000E-03,	-3.36000000E-03,
	3.37000000E-03,	3.41900000E-03,	-3.42100000E-03,
	-1.00700000E-01,	1.00500000E-01,	1.00700000E-01,
	-1.00500000E-01,		
Row 21	8.51800000E-04,	1.73100000E-06,	-2.48500000E-02,
	2.63900000E-02,	-2.65300000E-02,	2.49900000E-02,
	5.09500000E-02,	5.07900000E-02,	-5.09500000E-02,
	-5.07900000E-02,		
Row 22	4.03000000E-03,	-2.42200000E-06,	-6.47500000E-04,
	-3.01400000E-03,	3.02500000E-03,	6.35800000E-04,
	-2.41800000E-01,	-2.41300000E-01,	2.41800000E-01,
	2.41300000E-01		

APPENDIX C

KEDDC GENERATED DESIGN RESULTS

This appendix contains the KEDDC-generated results corresponding to the design cases specified in Appendix B.

SPAR

State Weighting Matrix

Matrix Q :

MATRIX A FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 5
DIMENSION 22X22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.010000E-06	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	1.010000E-06	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	1.664000E-06	-7.019000E-10	-1.684000E-09
(4)	0.00000	0.00000	-7.019000E-10	2.203000E-06	1.535000E-06
(5)	0.00000	0.00000	-1.684000E-09	1.535000E-06	5.901000E-06
(6)	0.00000	0.00000	-1.669000E-10	-1.388000E-05	-9.374000E-06
(7)	0.00000	0.00000	1.281000E-05	-5.342000E-09	-1.244000E-08
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	-4.923000E-10	-3.452000E-07	2.539000E-06
(16)	0.00000	0.00000	-1.237000E-06	1.122000E-09	1.565000E-08
(17)	0.00000	0.00000	-3.737000E-10	-7.123000E-07	-1.476000E-05
(18)	0.00000	0.00000	-4.531000E-09	-6.014000E-06	-3.550000E-06
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	-1.669000E-10	1.281000E-05	0.00000	0.00000	0.00000
(4)	-1.388000E-05	-5.342000E-09	0.00000	0.00000	0.00000
(5)	-9.374000E-06	-1.244000E-08	0.00000	0.00000	0.00000
(6)	1.791100E-04	-9.717000E-10	0.00000	0.00000	0.00000
(7)	-9.717000E-10	1.999100E-04	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	-3.295000E-06	4.331000E-09	0.00000	0.00000	0.00000
(16)	-3.628000E-09	-5.198000E-06	0.00000	0.00000	0.00000
(17)	2.724000E-06	-1.999000E-08	0.00000	0.00000	0.00000
(18)	-3.001000E-06	-9.630000E-09	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix Q (cont'd):

SPAR

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	-4.923000E-10
(4)	0.00000	0.00000	0.00000	0.00000	-3.452000E-07
(5)	0.00000	0.00000	0.00000	0.00000	2.539000E-06
(6)	0.00000	0.00000	0.00000	0.00000	-3.295000E-06
(7)	0.00000	0.00000	0.00000	0.00000	4.331000E-09
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	2.024000E-06
(16)	0.00000	0.00000	0.00000	0.00000	8.746000E-09
(17)	0.00000	0.00000	0.00000	0.00000	-8.075000E-06
(18)	0.00000	0.00000	0.00000	0.00000	3.891000E-06
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	-1.237000E-06	-3.737000E-10	-4.531000E-09	0.00000	0.00000
(4)	1.122000E-09	-7.123000E-07	-6.014000E-06	0.00000	0.00000
(5)	1.565000E-08	-1.476000E-05	-3.550000E-06	0.00000	0.00000
(6)	-3.628000E-09	2.724000E-06	-3.001000E-06	0.00000	0.00000
(7)	-5.198000E-06	-1.999000E-08	-9.630000E-09	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	8.746000E-09	-8.075000E-06	3.891000E-06	0.00000	0.00000
(16)	1.125000E-06	-4.195000E-08	5.237000E-09	0.00000	0.00000
(17)	-4.195000E-08	4.248000E-05	3.417000E-07	0.00000	0.00000
(18)	5.237000E-09	3.417000E-07	3.515000E-05	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	0.00000	0.00000
(16)	0.00000	0.00000
(17)	0.00000	0.00000
(18)	0.00000	0.00000
(19)	0.00000	0.00000
(20)	0.00000	0.00000
(21)	0.00000	0.00000
(22)	0.00000	0.00000

Input Weighting Matrix

Matrix R :

MATRIX A FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 6
DIMENSION 10X10, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.047105E-06	4.384989E-11	2.332973E-11	-1.114938E-11	1.928980E-11
(2)	4.384989E-11	1.000036E-06	-2.061491E-12	2.279372E-12	2.210752E-12
(3)	2.332973E-11	-2.061491E-12	1.000209E-06	-2.045284E-10	1.592059E-10
(4)	-1.114938E-11	2.279372E-12	-2.045284E-10	1.000200E-06	-1.544423E-10
(5)	1.928980E-11	2.210752E-12	1.592059E-10	-1.544423E-10	1.000207E-06
(6)	-3.144652E-11	-2.428639E-12	-1.635731E-10	1.584435E-10	-2.114529E-10
(7)	-1.115925E-06	4.924645E-10	6.951612E-10	-9.908137E-10	-3.057874E-09
(8)	-1.119510E-06	-2.554660E-09	-2.965676E-09	2.700253E-09	9.906418E-10
(9)	1.115925E-06	-4.924645E-10	-6.951612E-10	9.908137E-10	3.057874E-09
(10)	1.119510E-06	2.554660E-09	2.965676E-09	-2.700253E-09	-9.906418E-10

	(6)	(7)	(8)	(9)	(10)
(1)	-3.144652E-11	-1.115925E-06	-1.119510E-06	1.115925E-06	1.119510E-06
(2)	-2.428639E-12	4.924645E-10	-2.554660E-09	-4.924645E-10	2.554660E-09
(3)	-1.635731E-10	6.951612E-10	-2.965676E-09	-6.951612E-10	2.965676E-09
(4)	1.584435E-10	-9.908137E-10	2.700253E-09	9.908137E-10	-2.700253E-09
(5)	-2.114529E-10	-3.057874E-09	9.906418E-10	3.057874E-09	-9.906418E-10
(6)	1.000216E-06	3.352510E-09	-7.262341E-10	-3.352510E-09	7.262341E-10
(7)	3.352510E-09	2.768744E-05	2.627973E-05	-2.668744E-05	-2.627973E-05
(8)	-7.262341E-10	2.627973E-05	2.785915E-05	-2.627973E-05	-2.685915E-05
(9)	-3.352510E-09	-2.668744E-05	-2.627973E-05	2.768744E-05	2.627973E-05
(10)	7.262341E-10	-2.627973E-05	-2.685915E-05	2.627973E-05	2.785915E-05

Matrix F :

DIMENSION 10*22, SAMPLING TIME = 10.000

	(1)	(2)	(3)	(4)	(5)
(1)	-3.088681E-02	7.569280E-06	4.267244E-05	-.161888	-.130192
(2)	2.472261E-06	-3.191892E-02	.149165	-8.901303E-05	-2.728658E-04
(3)	.137403	-.139165	6.154056E-02	.106616	.290366
(4)	.196652	.139129	-6.141070E-02	.100143	-.240229
(5)	-.196727	.138294	-6.181112E-02	-9.986979E-02	.240771
(6)	-.137438	-.138257	6.168212E-02	-.106597	-.290787
(7)	1.062000E-02	-9.143760E-03	-2.411777E-02	-1.820942E-02	5.325847E-03
(8)	1.063060E-02	9.159369E-03	2.415545E-02	-1.826868E-02	5.350483E-03
(9)	-1.062000E-02	9.143760E-03	2.411777E-02	1.820942E-02	-5.325847E-03
(10)	-1.063060E-02	-9.159369E-03	-2.415545E-02	1.826868E-02	-5.350483E-03

	(6)	(7)	(8)	(9)	(10)
(1)	2.04539	-3.929860E-05	-.651041	3.987127E-04	1.482678E-03
(2)	-1.984812E-05	2.09875	-3.786841E-05	-.430010	1.87399
(3)	6.341671E-02	-3.952171E-02	2.08556	-1.92206	1.10511
(4)	2.404660E-02	3.958551E-02	2.74267	1.92300	-1.09854
(5)	-2.397307E-02	3.958047E-02	-2.74351	1.90587	-1.11549
(6)	-6.345647E-02	-3.964410E-02	-2.08756	-1.90680	1.10895
(7)	1.452607E-02	1.597609E-02	.384114	-.235121	-.634888
(8)	1.455100E-02	-1.599540E-02	.384050	.235149	.634364
(9)	-1.452607E-02	-1.597609E-02	-.384114	.235121	.634888
(10)	-1.455100E-02	1.599540E-02	-.384050	-.235149	-.634364

	(11)	(12)	(13)	(14)	(15)
(1)	-1.61200	-1.53294	24.2264	-2.730260E-04	-4.570013E-03
(2)	-9.565942E-04	-2.722805E-03	-2.675503E-04	24.5554	-5.533594E-05
(3)	2.03834	3.72661	.511251	-.289025	3.723438E-02
(4)	3.04057	-2.94385	8.091137E-02	.289078	2.645726E-02
(5)	-3.03826	2.94771	-8.054470E-02	.290162	-2.640565E-02
(6)	-2.03423	-3.72780	-.511550	-.290216	-3.717417E-02
(7)	-.814965	1.614568E-02	.109918	5.434319E-02	-1.077566E-02
(8)	-.815047	1.584844E-02	.110334	-5.438250E-02	-1.061421E-02
(9)	.814965	-1.614568E-02	-.109918	-5.434319E-02	1.077566E-02
(10)	.815047	-1.584844E-02	-.110334	5.438250E-02	1.061421E-02

	(16)	(17)	(18)	(19)	(20)
(1)	8.655782E-06	3.277730E-02	-2.565098E-02	-.230862	1.566809E-04
(2)	3.631011E-02	1.610194E-04	-7.319051E-05	6.397784E-05	-8.604247E-02
(3)	1.450493E-02	-.403916	.122650	.773415	-1.484834E-02
(4)	-1.449596E-02	.345304	8.509793E-02	-1.03085	1.450806E-02
(5)	-1.489701E-02	-.346401	-8.483875E-02	1.03106	1.501992E-02
(6)	1.488831E-02	.405038	-.122524	-.774590	-1.468100E-02
(7)	1.215310E-02	1.057636E-02	-3.334874E-03	-.100939	-.106062
(8)	-1.218245E-02	1.037218E-02	-3.427208E-03	-9.957709E-02	.106011
(9)	-1.215310E-02	-1.057636E-02	3.334874E-03	.100939	.106062
(10)	1.218245E-02	-1.037218E-02	3.427208E-03	9.957709E-02	-.106011

	(21)	(22)
(1)	-.106886	4.266375E-02
(2)	-7.949852E-05	-4.522659E-05
(3)	.854571	-.254207
(4)	-1.06435	-8.995549E-02
(5)	1.06525	8.884776E-02
(6)	-.855728	.254983
(7)	4.696912E-02	-7.287230E-02
(8)	4.683974E-02	-7.253328E-02
(9)	-4.696912E-02	7.287230E-02
(10)	-4.683974E-02	7.253328E-02

Eigenvalues of $(\bar{A}_c - \bar{B}_c F)$:

REAL PART	IMAGINARY PART	ABS. VALUE
-.889177	0.00000	.889177
.265378	.830902	.872252
.265378	-.830902	.872252
.715978	.589005	.927120
.715978	-.589005	.927120
4.130032E-02	.612739	.614130
4.130032E-02	-.612739	.614130
.603501	.144508	.620561
.603501	-.144508	.620561
.220171	.347227	.411147
.220171	-.347227	.411147
7.074465E-02	.333628	.341046
7.074465E-02	-.333628	.341046
.252841	.121781	.280640
.252841	-.121781	.280640
-.116777	.196464	.228550
-.116777	-.196464	.228550
-.349346	0.00000	.349346
-.337450	0.00000	.337450
-9.911202E-02	0.00000	9.911202E-02
-6.662694E-02	0.00000	6.662694E-02
-4.891947E-02	0.00000	4.891947E-02

Matrix $\bar{Q}$:

MATRIX A FROM FILE DZM , BLOCKNO. 5, MATRIXNO. 1
DIMENSION 22*22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.010000E-05	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	1.010000E-05	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	1.664000E-05	-7.019000E-09	-1.684000E-08
(4)	0.00000	0.00000	-7.019000E-09	2.203000E-05	1.535000E-05
(5)	0.00000	0.00000	-1.684000E-08	1.535000E-05	5.901000E-05
(6)	0.00000	0.00000	-1.669000E-09	-1.388000E-04	-9.374000E-05
(7)	0.00000	0.00000	1.281000E-04	-5.342000E-08	-1.244000E-07
(8)	5.050000E-05	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	5.050000E-05	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	8.320000E-05	-3.509500E-08	-8.420000E-08
(11)	0.00000	0.00000	-3.509500E-08	1.101500E-04	7.675000E-05
(12)	0.00000	0.00000	-8.420000E-08	7.675000E-05	2.950500E-04
(13)	0.00000	0.00000	-8.345000E-09	-6.940000E-04	-4.687000E-04
(14)	0.00000	0.00000	6.405000E-04	-2.671000E-07	-6.220000E-07
(15)	0.00000	0.00000	-3.783999E-09	-2.650907E-06	1.940416E-05
(16)	0.00000	0.00000	-3.573663E-06	3.055372E-09	4.587164E-08
(17)	0.00000	0.00000	7.293585E-10	7.797022E-07	1.562189E-05
(18)	0.00000	0.00000	-5.503248E-09	-6.677776E-06	-3.606031E-06
(19)	0.00000	0.00000	-2.098361E-08	-1.487854E-05	1.101379E-04
(20)	0.00000	0.00000	-3.701971E-05	3.382406E-08	4.661778E-07
(21)	0.00000	0.00000	-3.932367E-10	-5.518165E-07	-1.499510E-05
(22)	0.00000	0.00000	-6.848439E-09	-9.155482E-06	-5.023071E-06

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	5.050000E-05	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	5.050000E-05	0.00000
(3)	-1.669000E-09	1.281000E-04	0.00000	0.00000	8.320000E-05
(4)	-1.388000E-04	-5.342000E-08	0.00000	0.00000	-3.509500E-08
(5)	-9.374000E-05	-1.244000E-07	0.00000	0.00000	-8.420000E-08
(6)	1.791100E-03	-9.717000E-09	0.00000	0.00000	-8.345000E-09
(7)	-9.717000E-09	1.999100E-03	0.00000	0.00000	6.405000E-04
(8)	0.00000	0.00000	3.366667E-04	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	3.366667E-04	0.00000
(10)	-8.345000E-09	6.405000E-04	0.00000	0.00000	5.546667E-04
(11)	-6.940000E-04	-2.671000E-07	0.00000	0.00000	-2.339667E-07
(12)	-4.687000E-04	-6.220000E-07	0.00000	0.00000	-5.613333E-07
(13)	8.955500E-03	-4.858500E-08	0.00000	0.00000	-5.563333E-08
(14)	-4.858500E-08	9.995500E-03	0.00000	0.00000	4.270000E-03
(15)	-2.514704E-05	3.300287E-08	0.00000	0.00000	-1.614555E-08
(16)	-1.085575E-08	-1.501689E-05	0.00000	0.00000	1.805752E-06
(17)	-2.676595E-06	2.233949E-08	0.00000	0.00000	6.450357E-09
(18)	-3.756053E-06	-1.192476E-08	0.00000	0.00000	-4.349300E-08
(19)	-1.434837E-04	1.897194E-07	0.00000	0.00000	-1.361753E-07
(20)	-1.072416E-07	-1.555606E-04	0.00000	0.00000	-2.168764E-04
(21)	2.747949E-06	-2.066612E-08	0.00000	0.00000	1.050016E-08
(22)	-4.560034E-06	-1.400919E-08	0.00000	0.00000	-2.994762E-09

Matrix A (cont'd):

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	-3.509500E-08	-8.420000E-08	-8.345000E-09	6.405000E-04	-3.783999E-09
(4)	1.101500E-04	7.675000E-05	-6.940000E-04	-2.671000E-07	-2.650907E-06
(5)	7.675000E-05	2.950500E-04	-4.687000E-04	-6.220000E-07	1.940416E-05
(6)	-6.940000E-04	-4.687000E-04	8.955500E-03	-4.858500E-08	-2.514704E-05
(7)	-2.671000E-07	-6.220000E-07	-4.858500E-08	9.995500E-03	3.300287E-08
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	-2.339667E-07	-5.613333E-07	-5.563333E-08	4.270000E-03	-1.614555E-08
(11)	7.343333E-04	5.116667E-04	-4.626667E-03	-1.780667E-06	-1.129201E-05
(12)	5.116667E-04	1.967000E-03	-3.124667E-03	-4.146667E-06	8.246326E-05
(13)	-4.626667E-03	-3.124667E-03	5.970333E-02	-3.239000E-07	-1.067503E-04
(14)	-1.780667E-06	-4.146667E-06	-3.239000E-07	6.663667E-02	1.399328E-07
(15)	-1.129201E-05	8.246326E-05	-1.067503E-04	1.399328E-07	1.267531E-05
(16)	-2.793203E-09	-1.804792E-08	2.627922E-09	7.587965E-06	2.953274E-08
(17)	8.294423E-06	1.806559E-04	-3.222387E-05	2.523997E-07	4.656841E-06
(18)	-5.386340E-05	-3.250391E-05	-2.909411E-05	-9.746649E-08	1.864934E-06
(19)	-9.697770E-05	7.142664E-04	-9.302094E-04	1.230618E-06	5.833447E-05
(20)	1.959307E-07	2.733520E-06	-6.292699E-07	-9.113369E-04	1.861980E-07
(21)	2.001852E-05	3.774820E-04	-6.919258E-05	5.114805E-07	-2.486989E-05
(22)	-3.599362E-06	2.240900E-06	-2.407631E-06	-1.278734E-09	5.658726E-06

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	-3.573663E-06	7.293585E-10	-5.503248E-09	-2.098361E-08	-3.701971E-05
(4)	3.055372E-09	7.797022E-07	-6.677776E-06	-1.487854E-05	3.382406E-08
(5)	4.587164E-08	1.562189E-05	-3.606031E-06	1.101379E-04	4.661778E-07
(6)	-1.085575E-08	-2.676595E-06	-3.756053E-06	-1.434837E-04	-1.072416E-07
(7)	-1.501689E-05	2.233949E-08	-1.192476E-08	1.897194E-07	-1.555606E-04
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	1.805752E-06	6.450357E-09	-4.349300E-08	-1.361753E-07	-2.168764E-04
(11)	-2.793203E-09	8.294423E-06	-5.386340E-05	-9.697770E-05	1.959307E-07
(12)	-1.804792E-08	1.806559E-04	-3.250391E-05	7.142664E-04	2.733520E-06
(13)	2.627922E-09	-3.222387E-05	-2.909411E-05	-9.302094E-04	-6.292699E-07
(14)	7.587965E-06	2.523997E-07	-9.746649E-08	1.230618E-06	-9.113369E-04
(15)	2.953274E-08	4.656841E-06	1.864934E-06	5.833447E-05	1.861980E-07
(16)	4.422465E-06	-2.752401E-08	-2.027811E-09	6.688201E-09	4.764391E-06
(17)	-2.752401E-08	1.798022E-04	3.337326E-06	9.243211E-05	3.999351E-07
(18)	-2.027811E-09	3.337326E-06	1.461892E-04	2.585084E-05	1.486405E-08
(19)	6.688201E-09	9.243211E-05	2.585084E-05	4.830270E-04	1.318530E-06
(20)	4.764391E-06	3.999351E-07	1.486405E-08	1.318530E-06	1.159827E-04
(21)	-2.752457E-07	3.656792E-05	-7.149089E-06	1.486027E-04	1.671516E-07
(22)	6.894484E-09	3.364891E-06	2.874839E-05	8.854974E-07	-2.943877E-09

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	-3.932367E-10	-6.848439E-09
(4)	-5.518165E-07	-9.155482E-06
(5)	-1.499510E-05	-5.023071E-06
(6)	2.747949E-06	-4.560034E-06
(7)	-2.066612E-08	-1.400919E-08
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	1.050016E-08	-2.994762E-09
(11)	2.001852E-05	-3.599362E-06
(12)	3.774820E-04	2.240900E-06
(13)	-6.919258E-05	-2.407632E-06
(14)	5.114805E-07	-1.278735E-09
(15)	-2.486989E-05	5.658726E-06
(16)	-2.752457E-07	6.894484E-09
(17)	3.656792E-05	3.364891E-06
(18)	-7.149089E-06	2.874839E-05
(19)	1.486027E-04	8.854976E-07
(20)	1.671516E-07	-2.943876E-09
(21)	6.817072E-04	7.218725E-06
(22)	7.218725E-06	2.338961E-04

Matrix F̄ :

MATRIX A FROM FILE @@M , BLOCKNO. 6, MATRIXNO. 1
DIMENSION 10X22, SAMPLING TIME = 10.000

	(1)	(2)	(3)	(4)	(5)
(1)	-3.755822E-02	3.670387E-06	1.565783E-05	-.103766	-9.471437E-02
(2)	-8.589731E-06	-3.494730E-02	9.333142E-02	-3.079191E-05	-1.421397E-04
(3)	.156574	-.130723	6.365362E-02	.116120	.240370
(4)	.239983	.130710	-6.345957E-02	.147640	-.190670
(5)	-.240614	.129881	-6.369565E-02	-.146256	.191551
(6)	-.157165	-.129867	6.350849E-02	-.114930	-.239674
(7)	1.270726E-02	-7.705726E-03	-2.552452E-02	-2.594088E-02	1.062887E-02
(8)	1.275361E-02	7.716245E-03	2.560249E-02	-2.606286E-02	1.059306E-02
(9)	-1.270726E-02	7.705726E-03	2.552452E-02	2.594088E-02	-1.062887E-02
(10)	-1.275361E-02	-7.716245E-03	-2.560249E-02	2.606286E-02	-1.059306E-02

	(6)	(7)	(8)	(9)	(10)
(1)	1.32924	-1.376765E-06	-.755946	2.619105E-04	9.656976E-04
(2)	-1.486393E-05	1.33728	-2.820651E-04	-.564056	1.45401
(3)	7.328297E-03	-4.307652E-03	2.41687	-2.03275	1.12984
(4)	-1.299910E-02	4.345481E-03	3.50002	2.03404	-1.12165
(5)	1.294557E-02	4.345999E-03	-3.51547	2.01759	-1.13485
(6)	-7.336649E-03	-4.382374E-03	-2.43346	-2.01884	1.12681
(7)	3.077545E-03	3.566916E-03	.446485	-.204761	-.602295
(8)	3.093637E-03	-3.610001E-03	.447277	.204637	.601864
(9)	-3.077545E-03	-3.566916E-03	-.446485	.204761	.602295
(10)	-3.093637E-03	3.610001E-03	-.447277	-.204637	-.601864

	(11)	(12)	(13)	(14)	(15)
(1)	-1.31240	-1.45470	21.0137	-5.267182E-05	1.166552E-02
(2)	-1.440605E-04	-2.056836E-03	-2.420523E-04	21.0908	1.215025E-05
(3)	2.18669	3.90566	8.483404E-02	-3.989380E-02	1.416715E-02
(4)	3.49254	-3.22395	-.158871	3.986701E-02	.119294
(5)	-3.46274	3.24408	.157230	4.055027E-02	-.118911
(6)	-2.15512	-3.88681	-8.595382E-02	-4.052217E-02	-1.333164E-02
(7)	-.978098	.104218	2.074472E-02	-1.302216E-02	-1.460425E-02
(8)	-.979973	.103119	2.103403E-02	1.289146E-02	-1.456164E-02
(9)	.978098	-.104218	-2.074472E-02	1.302216E-02	1.460425E-02
(10)	.979973	-.103119	-2.103403E-02	-1.289146E-02	1.456164E-02

	(16)	(17)	(18)	(19)	(20)
(1)	2.747708E-05	-2.916944E-02	2.561361E-02	-6.878743E-02	1.984173E-04
(2)	3.438513E-02	-4.076979E-05	-9.583304E-06	3.200981E-05	8.824755E-02
(3)	2.343236E-02	2.604503E-02	-1.680252E-02	.433761	.144529
(4)	-2.345445E-02	.218418	5.843044E-02	-.901250	-.143882
(5)	-2.374225E-02	-.223953	-5.912490E-02	.895436	-.147548
(6)	2.376463E-02	-3.148936E-02	1.590097E-02	-.436524	.146912
(7)	2.053384E-02	2.306229E-02	-3.588005E-02	-.151697	-6.900778E-02
(8)	-2.061593E-02	2.342332E-02	-3.581291E-02	-.150555	6.918425E-02
(9)	-2.053384E-02	-2.306229E-02	3.588005E-02	.151697	6.900778E-02
(10)	2.061593E-02	-2.342332E-02	3.581291E-02	.150555	-6.918425E-02

	(21)	(22)
(1)	2.915624E-02	6.539820E-02
(2)	6.954007E-05	1.249667E-05
(3)	4.957251E-02	-.141455
(4)	.244296	6.641698E-02
(5)	-.271665	-6.558521E-02
(6)	-7.619250E-02	.140638
(7)	-6.610915E-02	-6.868231E-02
(8)	-6.618318E-02	-6.914983E-02
(9)	6.610915E-02	6.868231E-02
(10)	6.618318E-02	6.914983E-02

Eigenvalues of $(\bar{A}_c - \bar{B}_c \bar{F})$:

REAL PART	IMAGINARY PART	ABS. VALUE
.673798	.576293	.886633
.673798	-.576293	.886633
.212455	.788442	.816565
.212455	-.788442	.816565
-.519056	0.00000	.519056
.454243	.191452	.492940
.454243	-.191452	.492940
2.375548E-02	.406542	.407236
2.375548E-02	-.406542	.407236
.169498	.220877	.278417
.169498	-.220877	.278417
7.702811E-02	.130337	.151397
7.702811E-02	-.130337	.151397
4.518098E-02	8.160962E-02	9.328157E-02
4.518098E-02	-8.160962E-02	9.328157E-02
-1.626908E-02	0.00000	1.626908E-02
5.610406E-02	1.341874E-02	5.768646E-02
5.610406E-02	-1.341874E-02	5.768646E-02
5.313170E-02	0.00000	5.313170E-02
5.856703E-02	0.00000	5.856703E-02
1.649349E-02	0.00000	1.649349E-02
1.583798E-02	0.00000	1.583798E-02

Observer System Matrix

Matrix A_0 :

MATRIX A FROM FILE OBSV1 , BLOCKNO. 3, MATRIXNO. 1
DIMENSION 22X22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	-.540000	1.00000	0.00000	0.00000	0.00000
(2)	-9.000864E-02	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	-.540000	1.00000	3.451659E-19
(4)	0.00000	0.00000	-9.000864E-02	0.00000	6.056286E-20
(5)	0.00000	0.00000	0.00000	0.00000	-.540000
(6)	0.00000	0.00000	0.00000	0.00000	-9.000864E-02
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	4.828088E-19	0.00000	2.884147E-19	0.00000
(2)	0.00000	9.190308E-20	0.00000	5.968935E-20	0.00000
(3)	0.00000	3.777451E-22	0.00000	5.691003E-22	0.00000
(4)	0.00000	-2.767658E-23	0.00000	-1.108422E-22	0.00000
(5)	1.00000	7.444626E-23	0.00000	2.101039E-22	0.00000
(6)	0.00000	-8.240787E-23	0.00000	1.636784E-22	0.00000
(7)	0.00000	-.540000	1.00000	7.271778E-19	0.00000
(8)	0.00000	-9.000864E-02	0.00000	1.096908E-19	0.00000
(9)	0.00000	-8.257462E-20	0.00000	-.540000	1.00000
(10)	0.00000	-6.795118E-21	0.00000	-9.000864E-02	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_0 (cont'd) :

	(11)	(12)	(13)	(14)	(15)
(1)	7.326835E-20	0.00000	6.486476E-23	0.00000	32.1046
(2)	2.196992E-20	0.00000	5.855014E-24	0.00000	5.35129
(3)	-2.165210E-23	0.00000	4.235165E-22	0.00000	0.00000
(4)	-2.071395E-23	0.00000	7.782115E-21	0.00000	0.00000
(5)	3.625135E-23	0.00000	2.032879E-20	0.00000	0.00000
(6)	6.262849E-24	0.00000	1.154082E-20	0.00000	0.00000
(7)	-1.270549E-20	0.00000	1.793948E-22	0.00000	0.00000
(8)	-1.829062E-20	0.00000	7.651421E-24	0.00000	0.00000
(9)	1.240903E-19	0.00000	1.273858E-22	0.00000	0.00000
(10)	1.725830E-20	0.00000	1.778438E-23	0.00000	0.00000
(11)	-.540000	1.00000	2.998530E-24	0.00000	0.00000
(12)	-9.000864E-02	0.00000	5.105255E-25	0.00000	0.00000
(13)	0.00000	0.00000	-.540000	1.00000	0.00000
(14)	0.00000	0.00000	-9.000864E-02	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	37.3985
(16)	0.00000	0.00000	0.00000	0.00000	3.867695E-02
(17)	0.00000	0.00000	0.00000	0.00000	-7.41063
(18)	0.00000	0.00000	0.00000	0.00000	3.83166
(19)	0.00000	0.00000	0.00000	0.00000	1.94219
(20)	0.00000	0.00000	0.00000	0.00000	-4.868340E-03
(21)	0.00000	0.00000	0.00000	0.00000	-23.3345
(22)	0.00000	0.00000	0.00000	0.00000	4.48042

	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1)	0.00000	0.00000	-233.564	35.1717	-2.82757	-3.716940E-07	0.00000
(2)	0.00000	0.00000	-38.9310	5.86252	-.471307	-6.195495E-08	0.00000
(3)	32.1046	233.530	1.439773E-06	-.400490	4.125519E-06	-2.74305	0.00000
(4)	5.35129	38.9254	2.399852E-07	-6.675474E-02	6.876525E-07	-.457218	0.00000
(5)	0.00000	593.798	.218860	.194325	-1.331761E-06	4.03929	0.00000
(6)	0.00000	98.9759	3.648021E-02	3.239057E-02	-2.219815E-07	.673280	0.00000
(7)	0.00000	0.00000	515.759	-188.768	-5.06989	-2.253246E-03	0.00000
(8)	0.00000	0.00000	85.9681	-31.4644	-.845064	-3.755771E-04	0.00000
(9)	0.00000	0.00000	7.886783E-17	269.596	-5.59457	-8.565465E-03	0.00000
(10)	0.00000	0.00000	6.490084E-18	44.9369	-.932519	-1.427714E-03	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	77.7650	-7.630429E-04	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	12.9621	-1.271860E-04	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000	78.0234	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000	13.0051	0.00000
(15)	4.08393	-120.341	-606.730	1.00000	0.00000	0.00000	0.00000
(16)	-.532469	-.122223	-.615870	0.00000	1.00000	0.00000	0.00000
(17)	-.939469	24.5743	127.618	0.00000	0.00000	1.00000	0.00000
(18)	.440259	-12.4648	-63.5359	0.00000	0.00000	0.00000	1.00000
(19)	.203696	-6.27581	-31.5212	-1.846000E-03	-2.519000E-06	1.700000E-03	-3.255000E-03
(20)	-8.873964E-02	1.584843E-02	8.020484E-02	-2.519000E-06	-3.409000E-03	6.900000E-06	-1.146000E-05
(21)	-2.57515	74.6468	377.250	1.700000E-03	6.900000E-06	-1.711000E-02	4.585000E-03
(22)	.492449	-14.3252	-72.3625	-3.255000E-03	-1.146000E-05	4.585000E-03	-4.215000E-02

Matrix K_o :

MATRIX B FROM FILE OBSV1 , BLOCKNO. 3, MATRIXNO. 2
DIMENSION 22X13, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	32.1046	0.00000	0.00000	-233.564	35.1717
(2)	5.35129	0.00000	0.00000	-38.9310	5.86252
(3)	0.00000	32.1046	233.530	1.439773E-06	-.400490
(4)	0.00000	5.35129	38.9254	2.399852E-07	-6.675474E-02
(5)	0.00000	0.00000	593.798	.218860	.194325
(6)	0.00000	0.00000	98.9759	3.648021E-02	3.239057E-02
(7)	0.00000	0.00000	0.00000	515.759	-188.768
(8)	0.00000	0.00000	0.00000	85.9681	-31.4644
(9)	0.00000	0.00000	0.00000	7.886783E-17	269.596
(10)	0.00000	0.00000	0.00000	6.490084E-18	44.9369
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	-2.82757	-3.716940E-07	0.00000	0.00000	0.00000
(2)	-.471307	-6.195495E-08	0.00000	0.00000	0.00000
(3)	4.125519E-06	-2.74305	0.00000	0.00000	0.00000
(4)	6.876525E-07	-.457218	0.00000	0.00000	0.00000
(5)	-1.331761E-06	4.03929	0.00000	0.00000	0.00000
(6)	-2.219815E-07	.673280	0.00000	0.00000	0.00000
(7)	-5.06989	-2.253246E-03	0.00000	0.00000	0.00000
(8)	-.845064	-3.755771E-04	0.00000	0.00000	0.00000
(9)	-5.59457	-8.565465E-03	0.00000	0.00000	0.00000
(10)	-.932519	-1.427714E-03	0.00000	0.00000	0.00000
(11)	77.7650	-7.630429E-04	0.00000	0.00000	0.00000
(12)	12.9621	-1.271860E-04	0.00000	0.00000	0.00000
(13)	0.00000	78.0234	0.00000	0.00000	0.00000
(14)	0.00000	13.0051	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	-2346.17	-58.9683	-67.6119
(16)	0.00000	0.00000	-2.55619	46.9842	294.389
(17)	0.00000	0.00000	273.614	20.3698	63.2175
(18)	0.00000	0.00000	-204.837	-7.44891	-14.8922
(19)	0.00000	0.00000	-128.982	-2.29120	1.29369
(20)	0.00000	0.00000	.283525	2.71047	16.9254
(21)	0.00000	0.00000	1497.90	39.6463	60.8541
(22)	0.00000	0.00000	-305.217	-7.68846	-12.5784

Matrix K_o (cont'd) :

	(11)	(12)	(13)
(1)	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000
(15)	-120.810	6453.40	-65297.1
(16)	-5617.07	11.0099	-70.5430
(17)	-910.378	4302.61	8442.40
(18)	136.583	-375.769	-5854.62
(19)	-97.9969	517.856	-3563.07
(20)	-322.676	-.169975	7.98772
(21)	-283.577	-5019.24	41541.4
(22)	72.9770	1477.49	-8390.19

Matrix B_o :

```
MATRIX C FROM FILE  OBSV1 , BLOCKNO. 3, MATRIXNO. 3
DIMENSION 22*10, SAMPLING TIME =    .000
```

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	8.410000E-03	8.410000E-03	-8.410000E-03
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	-1.457000E-02	1.457000E-02	1.457000E-02
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	5.729000E-03	-5.729000E-03	-5.729000E-03
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	3.806000E-03	3.811000E-03	-3.806000E-03
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	1.022000E-02	-7.078000E-03	7.133000E-03
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	6.944000E-03	0.00000	1.289000E-03	4.539000E-05	-4.112000E-05
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	6.791000E-08	6.921000E-03	-8.075000E-04	8.081000E-04	8.094000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-5.553000E-04	-2.199000E-06	6.530000E-03	-3.478000E-03	3.488000E-03
(20)	-1.500000E-06	-2.577000E-03	-3.368000E-03	3.370000E-03	3.419000E-03
(21)	8.518000E-04	1.731000E-06	-2.485000E-02	2.639000E-02	-2.653000E-02
(22)	4.838000E-03	-2.422000E-06	-6.475000E-04	-3.014000E-03	3.025000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	-8.410000E-03	8.410000E-03	8.410000E-03	-8.410000E-03	-8.410000E-03
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	-1.457000E-02	-1.457000E-02	1.457000E-02	1.457000E-02	-1.457000E-02
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	5.729000E-03	-2.869000E-02	2.869000E-02	2.869000E-02	-2.869000E-02
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	-3.811000E-03	-1.906000E-02	-1.908000E-02	1.906000E-02	1.908000E-02
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	-1.027000E-02	9.299000E-03	9.284000E-03	-9.299000E-03	-9.284000E-03
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	-1.293000E-03	-2.675000E-04	-2.702000E-04	2.675000E-04	2.702000E-04
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	-8.100000E-04	9.735000E-04	-9.725000E-04	-9.735000E-04	9.725000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-6.539000E-03	-4.826000E-02	-4.783000E-02	4.826000E-02	4.783000E-02
(20)	-3.421000E-03	-.108700	.108500	.108700	-.108500
(21)	2.499000E-02	5.095000E-02	5.079000E-02	-5.095000E-02	-5.079000E-02
(22)	6.358000E-04	-.241800	-.241300	.241800	.241300

Eigenvalues of A_o ($= A_c - K_o C_c$) :

REAL PART	IMAGINARY PART	ABS. VALUE
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	0.00000	.270000
-.270000	0.00000	.270000
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014
-.270000	.130800	.300014
-.270000	-.130800	.300014

APPENDIX D

EVALUATION AND DESIGN MODELS FOR REGULATOR PROBLEM

In the following are listed the continuous-time system matrices for the evaluation model (A_p , B_p , C_p) and the design model (A_e , B_e , C_e) used in Ref.[4]; the latter is also listed in Appendix A.

Matrix A_p:

MATRIX A FROM FILE DZM , BLOCKNO. 1, MATRIXNO. 1
DIMENSION 36*36, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	0.00000	0.00000	0.00000	0.00000	0.00000
(33)	0.00000	0.00000	0.00000	0.00000	0.00000
(34)	0.00000	0.00000	0.00000	0.00000	0.00000
(35)	0.00000	0.00000	0.00000	0.00000	0.00000
(36)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd) :

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	1.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	1.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	1.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	0.00000	0.00000	0.00000	0.00000	0.00000
(33)	0.00000	0.00000	0.00000	0.00000	0.00000
(34)	0.00000	0.00000	0.00000	0.00000	0.00000
(35)	0.00000	0.00000	0.00000	0.00000	0.00000
(36)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd):

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	1.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	1.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	1.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	1.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	-1.546281E-02
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	0.00000	0.00000	0.00000	0.00000	0.00000
(33)	0.00000	0.00000	0.00000	0.00000	0.00000
(34)	0.00000	0.00000	0.00000	0.00000	0.00000
(35)	0.00000	0.00000	0.00000	0.00000	0.00000
(36)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd) :

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	-2.285538E-02	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	-5.737217E-02	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	-.309465	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	-.476378	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	-.607833
(32)	0.00000	0.00000	0.00000	0.00000	0.00000
(33)	0.00000	0.00000	0.00000	0.00000	0.00000
(34)	0.00000	0.00000	0.00000	0.00000	0.00000
(35)	0.00000	0.00000	0.00000	0.00000	0.00000
(36)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd) :

	(21)	(22)	(23)	(24)	(25)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	-2.41268	0.00000	0.00000	0.00000	0.00000
(33)	0.00000	-9.84003	0.00000	0.00000	0.00000
(34)	0.00000	0.00000	-15.6595	0.00000	0.00000
(35)	0.00000	0.00000	0.00000	-98.9811	0.00000
(36)	0.00000	0.00000	0.00000	0.00000	-196.233

Matrix A_p (cont'd) :

	(26)	(27)	(28)	(29)	(30)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	1.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	1.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	1.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	1.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	1.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	-1.846000E-03	5.509000E-06	-2.519000E-06	1.700000E-03	-1.237000E-03
(27)	5.509000E-06	-1.706000E-03	-3.644000E-04	-2.246000E-05	1.446000E-05
(28)	-2.519000E-06	-3.644000E-04	-3.409000E-03	6.900000E-06	-5.243000E-06
(29)	1.700000E-03	-2.246000E-05	6.900000E-06	-1.711000E-02	6.647000E-03
(30)	-1.237000E-03	1.446000E-05	-5.243000E-06	6.647000E-03	-1.109000E-02
(31)	-3.255000E-03	2.771000E-05	-1.146000E-05	4.585000E-03	-5.880000E-03
(32)	-4.718000E-05	3.210000E-03	8.921000E-03	2.764000E-05	-7.188000E-05
(33)	-1.500000E-03	1.495000E-05	-7.907000E-08	1.707000E-03	-2.124000E-03
(34)	-1.057000E-05	-2.151000E-03	-6.351000E-03	2.617000E-05	-2.508000E-05
(35)	1.173000E-03	-1.330000E-05	7.460000E-06	-4.837000E-03	2.683000E-04
(36)	2.607000E-03	-2.564000E-05	3.086000E-05	-8.077000E-03	1.308000E-03

Matrix A_p (cont'd):

	(31)	(32)	(33)	(34)	(35)	(36)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
(26)	-3.255000E-03	-4.718000E-05	-1.500000E-03	-1.057000E-05	1.173000E-03	2.607000E-03
(27)	2.771000E-05	3.210000E-03	1.495000E-05	-2.151000E-03	-1.330000E-05	-2.564000E-05
(28)	-1.146000E-05	8.921000E-03	-7.907000E-08	-6.351000E-03	7.460000E-06	3.086000E-05
(29)	4.585000E-03	2.764000E-05	1.707000E-03	2.617000E-05	-4.837000E-03	-8.077000E-03
(30)	-5.880000E-03	-7.188000E-05	-2.124000E-03	-2.508000E-05	2.683000E-04	1.308000E-03
(31)	-4.215000E-02	-6.426000E-04	-1.163000E-02	-7.470000E-05	-2.760000E-02	-3.694000E-02
(32)	-6.426000E-04	-.150100	-3.174000E-04	8.721000E-02	-5.814000E-04	-6.131000E-04
(33)	-1.163000E-02	-3.174000E-04	-5.610000E-02	2.360000E-05	.122900	.189600
(34)	-7.470000E-05	8.721000E-02	2.360000E-05	-.105600	-6.325000E-05	1.322000E-04
(35)	-2.760000E-02	-5.814000E-04	.122900	-6.325000E-05	-1.05500	-1.44600
(36)	-3.694000E-02	-6.131000E-04	.189600	1.322000E-04	-1.44600	-2.34200

Matrix B_p :

MATRIX B FROM FILE DZM , BLOCKNO. 1, MATRIXNO. 2
DIMENSION 36X10, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	8.410000E-03	8.410000E-03	-8.410000E-03
(9)	0.00000	0.00000	-1.457000E-02	1.457000E-02	1.457000E-02
(10)	0.00000	0.00000	5.729000E-03	-5.729000E-03	-5.729000E-03
(11)	0.00000	0.00000	3.806000E-03	3.811000E-03	-3.806000E-03
(12)	0.00000	0.00000	1.022000E-02	-7.078000E-03	7.133000E-03
(13)	6.944000E-03	0.00000	1.289000E-03	4.539000E-05	-4.112000E-05
(14)	6.791000E-08	6.921000E-03	-8.075000E-04	8.081000E-04	8.094000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	-5.553000E-04	-2.199000E-06	6.530000E-03	-3.478000E-03	3.488000E-03
(27)	5.403000E-06	-6.851000E-04	1.044000E-03	-1.055000E-03	-1.175000E-03
(28)	-1.500000E-06	-2.577000E-03	-3.368000E-03	3.370000E-03	3.419000E-03
(29)	8.518000E-04	1.731000E-06	-2.485000E-02	2.639000E-02	-2.653000E-02
(30)	1.688000E-05	-8.184000E-07	1.358000E-02	-1.328000E-02	1.336000E-02
(31)	4.838000E-03	-2.422000E-06	-6.475000E-04	-3.014000E-03	3.025000E-03
(32)	8.906000E-05	-2.665000E-03	4.183000E-03	-4.251000E-03	-4.594000E-03
(33)	-1.641000E-02	-3.707000E-06	-1.505000E-03	9.903000E-04	-1.007000E-03
(34)	9.890000E-06	-5.304000E-03	-1.833000E-03	1.826000E-03	2.062000E-03
(35)	.119700	-9.102000E-07	-5.342000E-04	6.243000E-04	-6.283000E-04
(36)	.180300	2.451000E-04	3.438000E-04	-3.829000E-04	4.334000E-04

Matrix B_p (cont'd):

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	-8.410000E-03	8.410000E-03	8.410000E-03	-8.410000E-03	-8.410000E-03
(9)	-1.457000E-02	-1.457000E-02	1.457000E-02	1.457000E-02	-1.457000E-02
(10)	5.729000E-03	-2.869000E-02	2.869000E-02	2.869000E-02	-2.869000E-02
(11)	-3.811000E-03	-1.906000E-02	-1.908000E-02	1.906000E-02	1.908000E-02
(12)	-1.027000E-02	9.299000E-03	9.284000E-03	-9.299000E-03	-9.284000E-03
(13)	-1.293000E-03	-2.675000E-04	-2.702000E-04	2.675000E-04	2.702000E-04
(14)	-8.100000E-04	9.735000E-04	-9.725000E-04	-9.735000E-04	9.725000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	-6.539000E-03	-4.826000E-02	-4.783000E-02	4.826000E-02	4.783000E-02
(27)	1.186000E-03	-5.105000E-02	5.178000E-02	5.105000E-02	-5.178000E-02
(28)	-3.421000E-03	-.108700	.108500	.108700	-.108500
(29)	2.499000E-02	5.095000E-02	5.079000E-02	-5.095000E-02	-5.079000E-02
(30)	-1.365000E-02	-4.925000E-02	-4.909000E-02	4.925000E-02	4.909000E-02
(31)	6.358000E-04	-.241800	-.241300	.241800	.241300
(32)	4.662000E-03	.263900	-.272400	-.263900	.272400
(33)	1.521000E-03	.340300	.340300	-.340300	-.340300
(34)	-2.055000E-03	-.415400	.414400	.415400	-.414400
(35)	5.383000E-04	-2.86100	-2.86200	2.86100	2.86200
(36)	-3.943000E-04	-4.25900	-4.27800	4.25900	4.27800

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Matrix C_p :

MATRIX C FROM FILE DZM , BLOCKNO. 1, MATRIXNO. 3
DIMENSION 13X36, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.682000E-02	0.00000	0.00000	7.617000E-03	3.139000E-03
(2)	0.00000	1.682000E-02	-6.615000E-03	2.807000E-06	3.172000E-05
(3)	0.00000	0.00000	9.094000E-04	-3.859000E-07	-9.257000E-07
(4)	0.00000	0.00000	0.00000	1.047000E-03	7.331000E-04
(5)	0.00000	0.00000	0.00000	0.00000	2.003000E-03
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	1.334000E-03	5.777000E-07	0.00000	0.00000	0.00000
(2)	2.464000E-06	9.338000E-04	0.00000	0.00000	0.00000
(3)	-9.174000E-08	-4.708000E-05	0.00000	0.00000	0.00000
(4)	1.210000E-04	1.119000E-07	0.00000	0.00000	0.00000
(5)	1.441000E-04	2.213000E-07	0.00000	0.00000	0.00000
(6)	6.944000E-03	6.791000E-08	0.00000	0.00000	0.00000
(7)	0.00000	6.921000E-03	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	3.051000E-03
(2)	0.00000	0.00000	0.00000	0.00000	5.393000E-06
(3)	0.00000	0.00000	0.00000	0.00000	-8.282000E-07
(4)	0.00000	0.00000	0.00000	0.00000	-5.856000E-04
(5)	0.00000	0.00000	0.00000	0.00000	1.157000E-03
(6)	0.00000	0.00000	0.00000	0.00000	-5.553000E-04
(7)	0.00000	0.00000	0.00000	0.00000	-2.199000E-06
(8)	0.00000	0.00000	0.00000	0.00000	-7.672000E-02
(9)	0.00000	0.00000	0.00000	0.00000	-1.057000E-04
(10)	0.00000	0.00000	0.00000	0.00000	9.647000E-05
(11)	0.00000	0.00000	0.00000	0.00000	4.200000E-06
(12)	0.00000	0.00000	0.00000	0.00000	5.736000E-05
(13)	0.00000	0.00000	0.00000	0.00000	3.335000E-03

	(16)	(17)	(18)	(19)	(20)
(1)	-1.135000E-05	1.986000E-06	1.541000E-03	2.933000E-04	-3.661000E-03
(2)	-1.287000E-03	3.920000E-03	-8.289000E-05	4.152000E-05	6.760000E-06
(3)	-3.625000E-04	-9.888000E-04	8.859000E-07	-1.407000E-06	-4.329000E-06
(4)	3.905000E-06	2.133000E-07	-3.964000E-04	-3.743000E-04	-5.918000E-03
(5)	-1.515000E-05	5.812000E-06	-5.932000E-03	3.110000E-03	2.746000E-04
(6)	5.403000E-06	-1.500000E-06	8.518000E-04	1.688000E-05	4.838000E-03
(7)	-6.851000E-04	-2.577000E-03	1.731000E-06	-8.184000E-07	-2.422000E-06
(8)	6.574000E-04	-1.386000E-04	.121800	-9.070000E-02	-.270900
(9)	-2.616000E-02	-2.193000E-02	-5.374000E-05	-2.032000E-05	-1.934000E-04
(10)	2.728000E-02	7.066000E-02	-4.218000E-05	4.595000E-05	1.590000E-04
(11)	1.211000E-03	3.425000E-03	-2.497000E-06	2.209000E-06	6.796000E-06
(12)	-2.287000E-06	1.776000E-06	-1.050000E-03	-5.249000E-04	-1.114000E-02
(13)	-3.071000E-05	8.002000E-06	-6.323000E-03	3.207000E-03	-6.592000E-04

Matrix C_p (cont'd):

	(21)	(22)	(23)	(24)	(25)
(1)	-6.865000E-05	-5.147000E-04	-7.681000E-06	9.009000E-05	-3.916000E-05
(2)	-5.107000E-03	-9.540000E-06	2.245000E-03	-2.352000E-06	2.916000E-05
(3)	9.650000E-03	3.582000E-06	-6.085000E-03	1.817000E-06	-1.854000E-06
(4)	-1.270000E-04	-2.459000E-03	2.712000E-06	-5.308000E-04	3.178000E-04
(5)	-4.746000E-05	-2.900000E-04	2.644000E-05	-1.342000E-04	8.974000E-05
(6)	8.906000E-05	-1.641000E-02	9.890000E-06	.119700	.180300
(7)	-2.665000E-03	-3.707000E-06	-5.304000E-03	-9.102000E-07	2.451000E-04
(8)	-4.318000E-03	-.100800	-5.008000E-04	-2.117000E-02	1.470000E-02
(9)	.434100	1.553000E-04	-.265200	7.903000E-05	-1.073000E-05
(10)	-.204600	-6.828000E-05	.133700	-3.800000E-05	6.639000E-05
(11)	-7.090000E-03	9.175000E-08	1.134000E-02	-8.927000E-07	-2.431000E-04
(12)	-2.104000E-04	1.367000E-02	-8.302000E-06	-.117800	-.176900
(13)	-3.270000E-05	-3.466000E-03	2.847000E-05	2.352000E-02	3.307000E-02

	(26)	(27)	(28)	(29)	(30)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(31)	(32)	(33)	(34)	(35)	(36)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_c :

MATRIX A FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 1
DIMENSION 22*22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	1.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	1.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	1.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_c (contd):

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	1.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	1.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	1.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	1.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	-1.546281E-02
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	1.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	1.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	-1.846000E-03	-2.519000E-06
(20)	-5.737217E-02	0.00000	0.00000	-2.519000E-06	-3.409000E-03
(21)	0.00000	-.309465	0.00000	1.700000E-03	6.900000E-06
(22)	0.00000	0.00000	-.607833	-3.255000E-03	-1.146000E-05

	(21)	(22)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	0.00000	0.00000
(16)	0.00000	0.00000
(17)	1.00000	0.00000
(18)	0.00000	1.00000
(19)	1.700000E-03	-3.255000E-03
(20)	6.900000E-06	-1.146000E-05
(21)	-1.711000E-02	4.585000E-03
(22)	4.585000E-03	-4.215000E-02

Matrix B_c :

MATRIX B FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 2
DIMENSION 22*10, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	8.410000E-03	8.410000E-03	-8.410000E-03
(9)	0.00000	0.00000	-1.457000E-02	1.457000E-02	1.457000E-02
(10)	0.00000	0.00000	5.729000E-03	-5.729000E-03	-5.729000E-03
(11)	0.00000	0.00000	3.806000E-03	3.811000E-03	-3.806000E-03
(12)	0.00000	0.00000	1.022000E-02	-7.078000E-03	7.133000E-03
(13)	6.944000E-03	0.00000	1.289000E-03	4.539000E-05	-4.112000E-05
(14)	6.791000E-08	6.921000E-03	-8.075000E-04	8.081000E-04	8.094000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-5.553000E-04	-2.199000E-06	6.530000E-03	-3.478000E-03	3.488000E-03
(20)	-1.500000E-06	-2.577000E-03	-3.368000E-03	3.370000E-03	3.419000E-03
(21)	8.518000E-04	1.731000E-06	-2.485000E-02	2.639000E-02	-2.653000E-02
(22)	4.838000E-03	-2.422000E-06	-6.475000E-04	-3.014000E-03	3.025000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	-8.410000E-03	8.410000E-03	8.410000E-03	-8.410000E-03	-8.410000E-03
(9)	-1.457000E-02	-1.457000E-02	1.457000E-02	1.457000E-02	-1.457000E-02
(10)	5.729000E-03	-2.869000E-02	2.869000E-02	2.869000E-02	-2.869000E-02
(11)	-3.811000E-03	-1.906000E-02	-1.908000E-02	1.906000E-02	1.908000E-02
(12)	-1.027000E-02	9.299000E-03	9.284000E-03	-9.299000E-03	-9.284000E-03
(13)	-1.293000E-03	-2.675000E-04	-2.702000E-04	2.675000E-04	2.702000E-04
(14)	-8.100000E-04	9.735000E-04	-9.725000E-04	-9.735000E-04	9.725000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-6.539000E-03	-4.826000E-02	-4.783000E-02	4.826000E-02	4.783000E-02
(20)	-3.421000E-03	-.108700	.108500	.108700	-.108500
(21)	2.499000E-02	5.095000E-02	5.079000E-02	-5.095000E-02	-5.079000E-02
(22)	6.358000E-04	-.241800	-.241300	.241800	.241300

MATRIX C FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 3
DIMENSION 13*22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	1.682000E-02	0.00000	0.00000	7.617000E-03	3.139000E-03
(2)	0.00000	1.682000E-02	-6.615000E-03	2.807000E-06	3.172000E-05
(3)	0.00000	0.00000	9.094000E-04	-3.859000E-07	-9.257000E-07
(4)	0.00000	0.00000	0.00000	1.047000E-03	7.331000E-04
(5)	0.00000	0.00000	0.00000	0.00000	2.003000E-03
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	1.334000E-03	5.777000E-07	0.00000	0.00000	0.00000
(2)	2.464000E-06	9.338000E-04	0.00000	0.00000	0.00000
(3)	-9.174000E-08	-4.708000E-05	0.00000	0.00000	0.00000
(4)	1.210000E-04	1.119000E-07	0.00000	0.00000	0.00000
(5)	1.441000E-04	2.213000E-07	0.00000	0.00000	0.00000
(6)	6.944000E-03	6.791000E-08	0.00000	0.00000	0.00000
(7)	0.00000	6.921000E-03	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	3.051000E-03
(2)	0.00000	0.00000	0.00000	0.00000	5.393000E-06
(3)	0.00000	0.00000	0.00000	0.00000	-8.282000E-07
(4)	0.00000	0.00000	0.00000	0.00000	-5.856000E-04
(5)	0.00000	0.00000	0.00000	0.00000	1.157000E-03
(6)	0.00000	0.00000	0.00000	0.00000	-5.553000E-04
(7)	0.00000	0.00000	0.00000	0.00000	-2.199000E-06
(8)	0.00000	0.00000	0.00000	0.00000	-7.672000E-02
(9)	0.00000	0.00000	0.00000	0.00000	-1.057000E-04
(10)	0.00000	0.00000	0.00000	0.00000	9.647000E-05
(11)	0.00000	0.00000	0.00000	0.00000	4.200000E-06
(12)	0.00000	0.00000	0.00000	0.00000	5.736000E-05
(13)	0.00000	0.00000	0.00000	0.00000	3.335000E-03

	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1)	1.986000E-06	1.541000E-03	-3.661000E-03	0.00000	0.00000	0.00000	0.00000
(2)	3.920000E-03	-8.289000E-05	6.760000E-06	0.00000	0.00000	0.00000	0.00000
(3)	-9.888000E-04	8.859000E-07	-4.329000E-06	0.00000	0.00000	0.00000	0.00000
(4)	2.133000E-07	-3.964000E-04	-5.918000E-03	0.00000	0.00000	0.00000	0.00000
(5)	5.812000E-06	-5.932000E-03	2.746000E-04	0.00000	0.00000	0.00000	0.00000
(6)	-1.500000E-06	8.518000E-04	4.838000E-03	0.00000	0.00000	0.00000	0.00000
(7)	-2.577000E-03	1.731000E-06	-2.422000E-06	0.00000	0.00000	0.00000	0.00000
(8)	-1.386000E-04	.121800	-.270900	0.00000	0.00000	0.00000	0.00000
(9)	-2.193000E-02	-5.374000E-05	-1.934000E-04	0.00000	0.00000	0.00000	0.00000
(10)	7.066000E-02	-4.218000E-05	1.590000E-04	0.00000	0.00000	0.00000	0.00000
(11)	3.425000E-03	-2.497000E-06	6.796000E-06	0.00000	0.00000	0.00000	0.00000
(12)	1.776000E-06	-1.050000E-03	-1.114000E-02	0.00000	0.00000	0.00000	0.00000
(13)	8.002000E-06	-6.323000E-03	-6.592000E-04	0.00000	0.00000	0.00000	0.00000

APPENDIX E

NOMINAL VALUES FOR ESTIMATOR-FEEDBACK REGULATOR PARAMETERS

This appendix lists the nominal values of the regulator parameters designed in Section 3 for the case $\rho = 10^{-6}$.

Matrix $(A_c - K C_c)$:

MATRIX A FROM FILE DZM , BLOCKNO. 8, MATRIXNO. 1
DIMENSION 22*22, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	-9.293634E-02	1.321112E-05	-6.095105E-06	-3.089583E-02	-1.024187E-02
(2)	1.293441E-05	-9.573065E-02	2.862162E-02	-1.847406E-06	-1.141023E-04
(3)	-5.893768E-06	2.867876E-02	-3.444202E-02	2.470468E-06	4.597267E-05
(4)	-3.082040E-02	-1.696716E-06	2.361427E-06	-3.801263E-02	-6.986856E-03
(5)	-1.029406E-02	-1.143443E-04	4.593341E-05	-7.027590E-03	-3.822611E-02
(6)	-3.103905E-03	-5.242722E-06	2.088927E-06	-1.475416E-03	-7.940247E-04
(7)	-8.325896E-07	-2.254360E-03	9.137619E-04	-7.986007E-07	-4.548513E-06
(8)	-4.835099E-03	6.972787E-07	-2.957732E-07	-2.053411E-03	-7.776337E-04
(9)	6.812115E-07	-4.979494E-03	1.857745E-03	-3.614254E-07	-8.217476E-06
(10)	-2.883858E-07	1.858359E-03	-1.000263E-03	1.841341E-07	3.268841E-06
(11)	-2.052626E-03	-3.541432E-07	1.807029E-07	-1.222556E-03	-4.241055E-04
(12)	-7.784922E-04	-8.218570E-06	3.267814E-06	-4.246735E-04	-8.067795E-04
(13)	-2.738856E-04	-4.767539E-07	1.891603E-07	-1.276634E-04	-6.254074E-05
(14)	-8.975803E-08	-1.976104E-04	7.903131E-05	-7.632363E-08	-3.991077E-07
(15)	-9.416549E-04	-1.550921E-06	6.093742E-07	-4.102519E-04	-2.264979E-04
(16)	7.435875E-07	-9.481080E-04	3.879694E-04	1.521911E-07	-1.810883E-06
(17)	-1.266434E-04	6.274475E-06	-2.470320E-06	-5.413919E-05	3.333928E-05
(18)	9.765677E-05	2.857585E-07	-1.074255E-07	5.311494E-05	2.731370E-05
(19)	-1.589359E-04	7.435206E-08	-3.048953E-08	-7.074567E-05	-3.405529E-05
(20)	-1.660187E-07	-1.479155E-04	5.926363E-05	-9.896549E-08	-3.342845E-07
(21)	3.605858E-05	9.111159E-07	-3.595936E-07	1.717075E-05	1.252388E-05
(22)	-2.946282E-06	-6.219530E-07	2.461920E-07	-7.001342E-07	-6.239135E-06

	(6)	(7)	(8)	(9)	(10)
(1)	-3.117985E-03	-9.348414E-07	1.00000	0.00000	0.00000
(2)	-5.171723E-06	-2.296889E-03	0.00000	1.00000	0.00000
(3)	2.063186E-06	9.222594E-04	0.00000	0.00000	1.00000
(4)	-1.481749E-03	-8.315121E-07	0.00000	0.00000	0.00000
(5)	-7.937059E-04	-4.647821E-06	0.00000	0.00000	0.00000
(6)	-6.650749E-02	-4.859381E-07	0.00000	0.00000	0.00000
(7)	-4.865342E-07	-6.629824E-02	0.00000	0.00000	0.00000
(8)	-2.742540E-04	-9.276633E-08	0.00000	0.00000	0.00000
(9)	-4.743121E-07	-1.986741E-04	0.00000	0.00000	0.00000
(10)	1.882177E-07	7.936719E-05	0.00000	0.00000	0.00000
(11)	-1.278268E-04	-7.760843E-08	0.00000	0.00000	0.00000
(12)	-6.255535E-05	-4.017737E-07	0.00000	0.00000	0.00000
(13)	-2.215387E-03	-4.297056E-08	0.00000	0.00000	0.00000
(14)	-4.296656E-08	-2.198089E-03	0.00000	0.00000	0.00000
(15)	2.703699E-05	-5.580542E-08	0.00000	0.00000	0.00000
(16)	-2.075416E-08	2.307187E-04	0.00000	0.00000	0.00000
(17)	-3.753491E-05	3.019954E-07	0.00000	0.00000	0.00000
(18)	-4.264311E-05	2.939175E-08	0.00000	0.00000	0.00000
(19)	1.333159E-07	-2.226628E-08	0.00000	0.00000	0.00000
(20)	-1.059128E-09	2.266189E-05	0.00000	0.00000	0.00000
(21)	-1.022902E-05	2.537901E-08	0.00000	0.00000	0.00000
(22)	4.760232E-07	-5.906489E-09	0.00000	0.00000	0.00000

SPAR

Matrix $(A_c - K C_c)$ (cont'd):

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	-9.653534E-03
(2)	0.00000	0.00000	0.00000	0.00000	3.257804E-07
(3)	0.00000	0.00000	0.00000	0.00000	2.352238E-05
(4)	1.00000	0.00000	0.00000	0.00000	1.020422E-02
(5)	0.00000	1.00000	0.00000	0.00000	-9.155541E-03
(6)	0.00000	0.00000	1.00000	0.00000	1.285744E-03
(7)	0.00000	0.00000	0.00000	1.00000	1.732578E-05
(8)	0.00000	0.00000	0.00000	0.00000	-3.465733E-04
(9)	0.00000	0.00000	0.00000	0.00000	-4.425033E-07
(10)	0.00000	0.00000	0.00000	0.00000	4.266740E-07
(11)	0.00000	0.00000	0.00000	0.00000	5.115989E-07
(12)	0.00000	0.00000	0.00000	0.00000	-1.782893E-04
(13)	0.00000	0.00000	0.00000	0.00000	2.596697E-05
(14)	0.00000	0.00000	0.00000	0.00000	4.732060E-07
(15)	0.00000	0.00000	0.00000	0.00000	-.168796
(16)	0.00000	0.00000	0.00000	0.00000	-1.876955E-04
(17)	0.00000	0.00000	0.00000	0.00000	3.870395E-02
(18)	0.00000	0.00000	0.00000	0.00000	-2.602974E-02
(19)	0.00000	0.00000	0.00000	0.00000	-2.722109E-02
(20)	0.00000	0.00000	0.00000	0.00000	-4.449521E-05
(21)	0.00000	0.00000	0.00000	0.00000	3.269043E-03
(22)	0.00000	0.00000	0.00000	0.00000	-8.579124E-03

	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1)	3.933968E-05	-3.264784E-02	8.753482E-03	0.00000	0.00000	0.00000	0.00000
(2)	-1.086155E-02	3.256584E-04	-4.403821E-05	0.00000	0.00000	0.00000	0.00000
(3)	2.907630E-02	-1.020224E-04	1.913824E-04	0.00000	0.00000	0.00000	0.00000
(4)	8.066767E-06	-2.935178E-02	.123841	0.00000	0.00000	0.00000	0.00000
(5)	-8.144454E-05	8.444582E-02	5.378627E-02	0.00000	0.00000	0.00000	0.00000
(6)	-5.379012E-07	-2.505455E-03	-5.705263E-02	0.00000	0.00000	0.00000	0.00000
(7)	2.119040E-02	-7.523364E-06	2.149350E-05	0.00000	0.00000	0.00000	0.00000
(8)	1.536872E-06	-1.518426E-03	2.453609E-03	0.00000	0.00000	0.00000	0.00000
(9)	-8.506519E-04	2.161180E-05	-9.561130E-07	0.00000	0.00000	0.00000	0.00000
(10)	6.170144E-04	-8.232879E-06	2.238500E-06	0.00000	0.00000	0.00000	0.00000
(11)	3.619707E-07	-7.447571E-04	2.583173E-03	0.00000	0.00000	0.00000	0.00000
(12)	-2.426326E-06	1.327707E-03	1.514712E-03	0.00000	0.00000	0.00000	0.00000
(13)	-4.854996E-08	-1.129514E-04	-1.788937E-03	0.00000	0.00000	0.00000	0.00000
(14)	6.474258E-04	3.834533E-07	5.829367E-07	0.00000	0.00000	0.00000	0.00000
(15)	-4.326207E-04	.267836	-.593737	1.00000	0.00000	0.00000	0.00000
(16)	-9.550333E-02	8.219357E-05	-3.695580E-04	0.00000	1.00000	0.00000	0.00000
(17)	7.626091E-05	-6.164706E-02	.136180	0.00000	0.00000	1.00000	0.00000
(18)	-6.450478E-05	4.132508E-02	-9.231698E-02	0.00000	0.00000	0.00000	1.00000
(19)	-2.478346E-05	1.862430E-02	-4.126533E-02	-1.846000E-03	-2.519000E-06	1.700000E-03	-3.255000E-03
(20)	-6.168701E-02	6.140790E-05	-1.433360E-04	-2.519000E-06	-3.409000E-03	6.900000E-06	-1.146000E-05
(21)	1.701514E-05	-.314660	1.139842E-02	1.700000E-03	6.900000E-06	-1.711000E-02	4.585000E-03
(22)	-2.741654E-05	1.363637E-02	-.638045	-3.255000E-03	-1.146000E-05	4.585000E-03	-4.215000E-02

Matrix K :

MATRIX B FROM FILE DZM , BLOCKNO. 8, MATRIXNO. 2
DIMENSION 22*13, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	5.52535	-7.854413E-04	9.890153E-04	-10.6884	.366191
(2)	-7.689898E-04	5.69148	9.92688	-4.241065E-03	-2.582080E-02
(3)	3.504024E-04	-1.70504	25.4708	9.050393E-03	1.195945E-02
(4)	1.83237	1.008749E-04	-1.862920E-03	22.9756	-7.79250
(5)	.612013	6.798117E-03	-1.059891E-03	2.25966	17.2982
(6)	.184537	3.116957E-04	-2.975533E-05	6.666672E-02	8.281638E-02
(7)	4.949998E-05	.134029	-2.986903E-02	3.229679E-05	4.514242E-05
(8)	.287461	-4.145533E-05	2.369277E-05	-.130068	-1.465457E-02
(9)	-4.050009E-05	.296046	.110622	-1.130827E-04	-4.296903E-04
(10)	1.714541E-05	-.110485	.296244	1.047961E-04	1.893825E-04
(11)	.122035	2.105489E-05	-4.555182E-05	.279863	-8.194206E-02
(12)	4.628372E-02	4.886189E-04	-3.914631E-05	6.889109E-02	.305030
(13)	1.628333E-02	2.834446E-05	-1.827255E-06	3.470056E-03	4.434629E-03
(14)	5.336387E-06	1.174854E-02	-1.445730E-03	2.044243E-06	3.422987E-06
(15)	5.598424E-02	9.220694E-05	6.319435E-07	-1.545399E-02	3.099838E-02
(16)	-4.420853E-05	5.636789E-02	-1.659975E-02	1.902078E-05	6.607744E-05
(17)	7.529336E-03	-3.730366E-04	2.950997E-06	-3.066579E-03	-2.731598E-02
(18)	-5.805991E-03	-1.698921E-05	-5.452116E-06	-8.491557E-03	-1.429358E-03
(19)	9.449223E-03	-4.420456E-06	1.372567E-06	-1.173873E-03	2.623510E-03
(20)	9.870318E-06	8.794027E-03	-1.199847E-03	-1.303313E-06	1.208178E-05
(21)	-2.143792E-03	-5.416860E-05	1.394609E-06	-8.035648E-04	-2.597954E-03
(22)	1.751654E-04	3.697699E-05	-1.747582E-06	-6.057354E-04	3.061498E-03

	(6)	(7)	(8)	(9)	(10)
(1)	-.433799	-4.807003E-05	.183793	2.516512E-04	-2.234295E-04
(2)	-3.861763E-04	-.368509	-1.329212E-04	1.032554E-02	-3.327063E-02
(3)	1.712033E-04	.270058	1.036432E-04	-1.394779E-02	4.494154E-02
(4)	-.377273	-1.776941E-04	-8.415427E-02	-1.281054E-04	1.542948E-04
(5)	-.401616	-8.896672E-04	.151271	2.273943E-04	-3.583999E-04
(6)	9.53936	-8.477622E-05	-4.411856E-02	-5.760388E-05	7.230501E-05
(7)	1.110336E-05	9.56100	2.672081E-05	-1.156707E-02	3.727030E-02
(8)	-1.315802E-02	-2.135875E-06	7.765848E-03	1.016931E-05	-7.512395E-06
(9)	-1.661410E-05	-1.048482E-02	2.094820E-06	9.094183E-04	-2.930258E-03
(10)	6.963222E-06	5.454543E-03	-1.968579E-07	-4.919981E-04	1.585276E-03
(11)	-8.211881E-03	-3.947685E-06	1.543640E-03	1.938618E-06	-1.139813E-06
(12)	-7.413452E-03	-2.279850E-05	3.638019E-03	6.581472E-06	-1.168181E-05
(13)	.315756	-2.283348E-06	-1.256383E-03	-1.564819E-06	1.914577E-06
(14)	8.678273E-07	.316002	7.898884E-07	-4.774466E-04	1.538380E-03
(15)	-1.502263E-02	-9.640256E-06	-2.19287	-2.555355E-03	1.005127E-03
(16)	-1.044186E-05	-4.105426E-02	-3.709708E-04	-.380431	1.22578
(17)	4.579347E-03	6.966121E-06	.503082	-3.050696E-04	-1.600252E-04
(18)	7.434014E-03	-1.396924E-06	-.339694	-2.475974E-04	1.716224E-04
(19)	-1.868459E-03	2.987656E-06	-.152507	-1.754665E-04	-3.783314E-06
(20)	-5.107966E-06	-4.469044E-03	-4.847226E-04	-1.?06148E-02	5.497183E-02
(21)	1.952847E-03	3.906948E-06	4.227307E-02	9.310945E-05	-1.246330E-04
(22)	-1.551920E-04	-4.248704E-06	-.111540	-7.983811E-05	1.410381E-04

Matrix K (cont'd):

	(11)	(12)	(13)
(1)	-9.684673E-06	-3.123349E-04	-8.181101E-03
(2)	-1.612681E-03	1.446797E-06	7.199072E-06
(3)	2.178388E-03	-6.581475E-07	-5.055251E-06
(4)	6.973861E-06	-5.730473E-04	2.961407E-03
(5)	-1.664644E-05	4.226763E-04	-5.985141E-03
(6)	3.285436E-06	1.618002E-04	2.057909E-03
(7)	1.806550E-03	2.711428E-07	-7.688681E-07
(8)	-3.149004E-07	-2.362875E-05	-3.571161E-04
(9)	-1.420343E-04	5.143573E-08	-3.773563E-08
(10)	7.684086E-05	-1.985562E-08	-1.061414E-08
(11)	-4.531254E-08	-1.551725E-05	-8.283728E-05
(12)	-5.477528E-07	2.400091E-06	-1.524631E-04
(13)	8.675986E-08	6.466703E-06	6.063617E-05
(14)	7.456769E-05	2.101523E-08	-7.553041E-09
(15)	3.462071E-05	6.114993E-03	.100234
(16)	5.941557E-02	3.150009E-05	5.284465E-05
(17)	-1.013944E-05	-7.245599E-03	-2.929256E-02
(18)	7.084907E-06	-1.654423E-02	-3.645148E-03
(19)	-1.296190E-06	7.175923E-04	7.293400E-03
(20)	2.664567E-03	3.847803E-06	2.500995E-05
(21)	-5.702935E-06	-2.602091E-03	-4.653924E-03
(22)	6.622374E-06	3.681957E-04	5.151916E-03

Matrix B_c :

MATRIX A FROM FILE DZM , BLOCKNO. 2, MATRIXNO. 2
DIMENSION 22*10, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	8.410000E-03	8.410000E-03	-8.410000E-03
(9)	0.00000	0.00000	-1.457000E-02	1.457000E-02	1.457000E-02
(10)	0.00000	0.00000	5.729000E-03	-5.729000E-03	-5.729000E-03
(11)	0.00000	0.00000	3.806000E-03	3.811000E-03	-3.806000E-03
(12)	0.00000	0.00000	1.022000E-02	-7.078000E-03	7.133000E-03
(13)	6.944000E-03	0.00000	1.289000E-03	4.539000E-05	-4.112000E-05
(14)	6.791000E-08	6.921000E-03	-8.075000E-04	8.081000E-04	8.094000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-5.553000E-04	-2.199000E-06	6.530000E-03	-3.478000E-03	3.488000E-03
(20)	-1.500000E-06	-2.577000E-03	-3.368000E-03	3.370000E-03	3.419000E-03
(21)	8.518000E-04	1.731000E-06	-2.485000E-02	2.639000E-02	-2.653000E-02
(22)	4.838000E-03	-2.422000E-06	-6.475000E-04	-3.014000E-03	3.025000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	-8.410000E-03	8.410000E-03	8.410000E-03	-8.410000E-03	-8.410000E-03
(9)	-1.457000E-02	-1.457000E-02	1.457000E-02	1.457000E-02	-1.457000E-02
(10)	5.729000E-03	-2.869000E-02	2.869000E-02	2.869000E-02	-2.869000E-02
(11)	-3.811000E-03	-1.906000E-02	-1.908000E-02	1.906000E-02	1.908000E-02
(12)	-1.027000E-02	9.299000E-03	9.284000E-03	-9.299000E-03	-9.284000E-03
(13)	-1.293000E-03	-2.675000E-04	-2.702000E-04	2.675000E-04	2.702000E-04
(14)	-8.100000E-04	9.735000E-04	-9.725000E-04	-9.735000E-04	9.725000E-04
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	-6.539000E-03	-4.826000E-02	-4.783000E-02	4.826000E-02	4.783000E-02
(20)	-3.421000E-03	-.108700	.108500	.108700	-.108500
(21)	2.499000E-02	5.095000E-02	5.079000E-02	-5.095000E-02	-5.079000E-02
(22)	6.358000E-04	-.241800	-.241300	.241800	.241300

Matrix F :

DIMENSION 10*22, SAMFLING TIME = 1.000

	(1)	(2)	(3)	(4)	(5)
(1)	-4.771374E-02	2.101564E-04	3.852150E-04	-1.08101	-.774833
(2)	1.555301E-05	-4.318265E-02	1.00104	-4.959516E-04	-1.175276E-03
(3)	.324396	-.447177	.166953	.404037	1.30933
(4)	.519217	.447070	-.166727	.103168	-.951398
(5)	-.519406	.445034	-.167779	-.102323	.955217
(6)	-.324367	-.444927	.167553	-.404508	-1.31279
(7)	2.532142E-02	-.161756	-.264668	-5.333727E-02	1.088532E-03
(8)	2.275072E-02	.161524	.264290	-4.923320E-02	2.409685E-03
(9)	-2.532142E-02	.161756	.264668	5.333727E-02	-1.088532E-03
(10)	-2.275072E-02	-.161524	-.264290	4.923320E-02	-2.409685E-03

	(6)	(7)	(8)	(9)	(10)
(1)	13.3497	-6.686891E-04	-.560295	2.992590E-03	6.830964E-03
(2)	-8.167596E-05	14.0391	-6.254493E-04	-6.354393E-02	5.89402
(3)	.574953	-.626097	2.15116	-3.29031	2.19754
(4)	.275755	.626004	4.93289	3.29089	-2.18523
(5)	-.274709	.627560	-4.93354	3.26442	-2.21261
(6)	-.575970	-.627468	-2.15357	-3.26500	2.20032
(7)	.139480	.386551	.768518	-2.19813	-5.05415
(8)	.134970	-.385779	.688527	2.19415	5.04330
(9)	-.139480	-.386551	-.768518	2.19813	5.05415
(10)	-.134970	.385779	-.688527	-2.19415	-5.04330

	(11)	(12)	(13)	(14)	(15)
(1)	-5.43280	-3.67888	61.7358	-7.203709E-04	-.246150
(2)	-2.951187E-04	-5.997502E-03	-2.430845E-04	63.2871	5.526339E-04
(3)	6.60411	6.83688	2.18865	-1.96361	.584863
(4)	3.10796	-4.53613	.462751	1.96469	-.402134
(5)	-3.10824	4.54543	-.459468	1.96180	.402794
(6)	-6.59737	-6.84093	-2.19228	-1.96289	-.585426
(7)	-1.76129	-5.503113E-02	.465094	.243838	-4.809033E-02
(8)	-1.58634	-4.932574E-02	.461544	-.242813	-3.998548E-02
(9)	1.76129	5.503113E-02	-.465094	-.243838	4.809033E-02
(10)	1.58634	4.932574E-02	-.461544	.242813	3.998548E-02

	(16)	(17)	(18)	(19)	(20)
(1)	3.437935E-04	.197378	-.433031	-.747483	-6.917538E-04
(2)	-9.005361E-02	4.764543E-04	-1.664744E-03	2.001497E-03	-.999863
(3)	9.657421E-03	-1.92481	9.521877E-02	.995788	-.190350
(4)	-9.854474E-03	1.91548	-.211964	-1.89372	.190576
(5)	-7.418191E-03	-1.92764	.213350	1.89555	.194874
(6)	7.614997E-03	1.93655	-9.663489E-02	-.998595	-.195103
(7)	-.355577	2.687974E-02	-.134768	-4.255447E-02	.190440
(8)	.354848	1.641748E-02	-8.070050E-02	-4.489861E-02	-.189892
(9)	.355577	-2.687974E-02	.134768	4.255447E-02	-.190440
(10)	-.354848	-1.641748E-02	8.070050E-02	4.489861E-02	.189892

	(21)	(22)
(1)	.424750	-.463109
(2)	7.663621E-04	-5.222126E-04
(3)	-4.31701	-.673052
(4)	4.64984	.144078
(5)	-4.67244	-.147465
(6)	4.33999	.676275
(7)	5.545774E-02	-.321284
(8)	3.327133E-02	-.273966
(9)	-5.545774E-02	.321284
(10)	-3.327133E-02	.273966

APPENDIX F

EVALUATION MODEL SYSTEM MATRICES FOR TRACKING PROBLEM

Listed here are the system matrices for the evaluation model from Ref.[1] used in the tracking problem of Section 4.

Matrix Ap :

MATRIX A FROM FILE DZME , BLOCKNO. 1, MATRIXNO. 1
DIMENSION 32X32, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	-1.546280E-02	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	-2.285538E-02	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	-5.737217E-02	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	-.309465	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	-.476378
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd):

SPAR

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	-.607833	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	-1.04648	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	-1.18248	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	-2.41268	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	-98.9811
(32)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	0.00000	1.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	1.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	1.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	1.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	0.00000	0.00000	0.00000	0.00000
(23)	0.00000	0.00000	0.00000	0.00000	0.00000
(24)	0.00000	0.00000	0.00000	0.00000	0.00000
(25)	0.00000	0.00000	0.00000	0.00000	0.00000
(26)	0.00000	0.00000	0.00000	0.00000	0.00000
(27)	0.00000	0.00000	0.00000	0.00000	0.00000
(28)	0.00000	0.00000	0.00000	0.00000	0.00000
(29)	0.00000	0.00000	0.00000	0.00000	0.00000
(30)	0.00000	0.00000	0.00000	0.00000	0.00000
(31)	0.00000	0.00000	0.00000	0.00000	0.00000
(32)	-196.233	0.00000	0.00000	0.00000	0.00000

Matrix A_p (cont'd):

	(21)	(22)	(23)	(24)	(25)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	1.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	1.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	1.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	1.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	1.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	0.00000	-1.846000E-03	5.509000E-06	-2.519000E-06	1.700000E-03
(23)	0.00000	5.509000E-06	-1.706000E-03	-3.644000E-04	-2.246000E-05
(24)	0.00000	-2.519000E-06	-3.644000E-04	-3.409000E-03	6.900000E-06
(25)	0.00000	1.700000E-03	-2.246000E-05	6.900000E-06	-1.711000E-02
(26)	0.00000	-1.237000E-03	1.446000E-05	-5.243000E-06	6.647000E-03
(27)	0.00000	-3.255000E-03	2.771000E-05	-1.146000E-05	4.585000E-03
(28)	0.00000	-1.147000E-03	4.763000E-06	-1.468000E-05	2.881000E-04
(29)	0.00000	-6.976000E-04	3.154000E-06	-1.303000E-05	2.368000E-03
(30)	0.00000	-4.718000E-05	3.210000E-03	8.921000E-03	2.764000E-05
(31)	0.00000	1.173000E-03	-1.330000E-05	7.460000E-06	-4.837000E-03
(32)	0.00000	2.607000E-03	-2.564000E-05	3.086000E-05	-8.077000E-03

	(26)	(27)	(28)	(29)	(30)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	1.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	1.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	1.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	1.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	1.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000
(19)	0.00000	0.00000	0.00000	0.00000	0.00000
(20)	0.00000	0.00000	0.00000	0.00000	0.00000
(21)	0.00000	0.00000	0.00000	0.00000	0.00000
(22)	-1.237000E-03	-3.255000E-03	-1.147000E-03	-6.976000E-04	-4.718000E-05
(23)	1.446000E-05	2.771000E-05	4.763000E-06	3.154000E-06	3.210000E-03
(24)	-5.243000E-06	-1.146000E-05	-1.468000E-05	-1.303000E-05	8.921000E-03
(25)	6.647000E-03	4.585000E-03	2.881000E-04	2.368000E-03	2.764000E-05
(26)	-1.109000E-02	-5.880000E-03	-1.589000E-03	-1.852000E-03	-7.188000E-05
(27)	-5.880000E-03	-4.215000E-02	-1.460000E-02	-5.884000E-03	-6.426000E-04
(28)	-1.589000E-03	-1.460000E-02	-1.615000E-02	-2.200000E-03	-1.187000E-04
(29)	-1.852000E-03	-5.884000E-03	-2.200000E-03	-1.214000E-02	5.165000E-05
(30)	-7.188000E-05	-6.426000E-04	-1.187000E-04	5.165000E-05	-.150100
(31)	2.683000E-04	-2.760000E-02	1.294000E-02	-9.994000E-04	-5.814000E-04
(32)	1.308000E-03	-3.694000E-02	2.447000E-02	-3.922000E-04	-6.131000E-04

Matrix Ap (cont'd):

SPAR

	(31)	(32)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	1.00000	0.00000
(16)	0.00000	1.00000
(17)	0.00000	0.00000
(18)	0.00000	0.00000
(19)	0.00000	0.00000
(20)	0.00000	0.00000
(21)	0.00000	0.00000
(22)	1.173000E-03	2.607000E-03
(23)	-1.330000E-05	-2.564000E-05
(24)	7.460000E-06	3.086000E-05
(25)	-4.837000E-03	-8.077000E-03
(26)	2.683000E-04	1.308000E-03
(27)	-2.760000E-02	-3.694000E-02
(28)	1.294000E-02	2.447000E-02
(29)	-9.994000E-04	-3.922000E-04
(30)	-5.814000E-04	-6.131000E-04
(31)	-1.05500	-1.44600
(32)	-1.44600	-2.34200

Matrix Bp : SPAR

MATRIX B FROM FILE DZME , BLOCKNO. 1, MATRIXNO. 2
DIMENSION 32X 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	-1.145800E-02	0.00000
(18)	0.00000	0.00000	7.617000E-03	5.000009E-06	0.00000
(19)	0.00000	0.00000	3.142000E-03	5.500019E-05	1.735300E-02
(20)	6.944000E-03	0.00000	1.334390E-03	4.269999E-06	1.247880E-03
(21)	6.791000E-08	6.921000E-03	6.000046E-07	1.617500E-03	1.899985E-06
(22)	-5.553000E-04	-2.199000E-06	3.052000E-03	9.999989E-06	1.001800E-02
(23)	5.403000E-06	-6.851000E-04	-1.100000E-05	-2.230000E-03	-1.310000E-04
(24)	-1.500000E-06	-2.577000E-03	1.999986E-06	6.789000E-03	5.099998E-05
(25)	8.518000E-04	1.731000E-06	1.540000E-03	-1.400001E-04	-5.138000E-02
(26)	1.688000E-05	-8.184000E-07	3.000000E-04	8.000014E-05	2.694000E-02
(27)	4.838000E-03	-2.422000E-06	-3.661500E-03	1.100003E-05	2.377500E-03
(28)	-1.902000E-03	1.983000E-06	-1.227000E-03	-2.000015E-06	-5.431000E-03
(29)	1.847000E-04	2.357000E-06	-1.670000E-03	1.700036E-05	6.933000E-03
(30)	8.906000E-05	-2.665000E-03	-6.800005E-05	-8.845000E-03	-4.110001E-04
(31)	.119700	-9.102000E-07	9.010002E-05	-4.000001E-06	-1.162500E-03
(32)	.180300	2.451000E-04	-3.910001E-05	5.050001E-05	7.772000E-04

	(6)	(7)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	0.00000	0.00000
(13)	0.00000	0.00000
(14)	0.00000	0.00000
(15)	0.00000	0.00000
(16)	0.00000	0.00000
(17)	-2.869000E-02	2.869000E-02
(18)	-1.906000E-02	-1.908000E-02
(19)	9.299000E-03	9.284000E-03
(20)	-2.675000E-04	-2.702000E-04
(21)	9.735000E-04	-9.725000E-04
(22)	-1.039000E-02	-1.027000E-02
(23)	-6.580000E-03	6.696000E-03
(24)	1.806000E-02	-1.806000E-02
(25)	4.926000E-06	2.497000E-05
(26)	-1.654000E-04	-1.687000E-04
(27)	-4.750000E-03	-4.745000E-03
(28)	8.199000E-03	8.225000E-03
(29)	-4.896000E-04	5.119000E-04
(30)	6.010000E-03	-5.971000E-03
(31)	-5.333000E-04	-5.333000E-04
(32)	1.487000E-03	1.410000E-03

Matrix C_p :

MATRIX C FROM FILE DZME , BLOCKNO. 1, MATRIXNO. 3
DIMENSION 16*32, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	-4.708000E-05
(2)	0.00000	1.047000E-03	7.331000E-04	1.210000E-04	1.119000E-07
(3)	0.00000	0.00000	2.003000E-03	1.441000E-04	2.213000E-07
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	6.944000E-03	6.791000E-08
(11)	0.00000	0.00000	0.00000	0.00000	6.921000E-03
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	-8.282000E-07	-3.625000E-04	-9.888000E-04	8.859000E-07	-1.407000E-06
(2)	-5.856000E-04	3.905000E-06	2.133000E-07	-3.964000E-04	-3.743000E-04
(3)	1.157000E-03	-1.515000E-05	5.812000E-06	-5.932000E-03	3.110000E-03
(4)	-1.756000E-03	1.504000E-05	-3.172000E-06	2.786000E-03	-2.075000E-03
(5)	-2.418000E-06	-5.987000E-04	-5.019000E-04	-1.230000E-06	-4.650000E-07
(6)	2.208000E-06	6.242000E-04	1.617000E-03	-9.652000E-07	1.052000E-06
(7)	4.200000E-06	1.211000E-03	3.425000E-03	-2.497000E-06	2.209000E-06
(8)	5.736000E-05	-2.287000E-06	1.776000E-06	-1.050000E-03	-5.249000E-04
(9)	3.335000E-03	-3.071000E-05	8.002000E-06	-6.323000E-03	3.207000E-03
(10)	-5.553000E-04	5.403000E-06	-1.500000E-06	8.518000E-04	1.688000E-05
(11)	-2.199000E-06	-6.851000E-04	-2.577000E-03	1.731000E-06	-8.184000E-07
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	-8.282000E-07	-3.625000E-04	-9.888000E-04	8.859000E-07	-1.407000E-06
(2)	-5.856000E-04	3.905000E-06	2.133000E-07	-3.964000E-04	-3.743000E-04
(3)	1.157000E-03	-1.515000E-05	5.812000E-06	-5.932000E-03	3.110000E-03
(4)	-1.756000E-03	1.504000E-05	-3.172000E-06	2.786000E-03	-2.075000E-03
(5)	-2.418000E-06	-5.987000E-04	-5.019000E-04	-1.230000E-06	-4.650000E-07
(6)	2.208000E-06	6.242000E-04	1.617000E-03	-9.652000E-07	1.052000E-06
(7)	4.200000E-06	1.211000E-03	3.425000E-03	-2.497000E-06	2.209000E-06
(8)	5.736000E-05	-2.287000E-06	1.776000E-06	-1.050000E-03	-5.249000E-04
(9)	3.335000E-03	-3.071000E-05	8.002000E-06	-6.323000E-03	3.207000E-03
(10)	-5.553000E-04	5.403000E-06	-1.500000E-06	8.518000E-04	1.688000E-05
(11)	-2.199000E-06	-6.851000E-04	-2.577000E-03	1.731000E-06	-8.184000E-07
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix Cp (cont'd) :

	(11)	(12)	(13)	(14)	(15)
(1)	-4.329000E-06	-1.326000E-05	-1.198000E-05	9.650000E-03	1.817000E-06
(2)	-5.918000E-03	-2.589000E-03	-8.461000E-04	-1.270000E-04	-5.308000E-04
(3)	2.746000E-04	-6.272000E-04	8.006000E-04	-4.746000E-05	-1.342000E-04
(4)	-6.200000E-03	-1.845000E-03	-1.219000E-03	-9.882000E-05	-4.845000E-04
(5)	-4.426000E-06	-1.401000E-05	-1.236000E-05	9.933000E-03	1.808000E-06
(6)	3.638000E-06	7.070000E-06	6.100000E-06	-4.682000E-03	-8.696000E-07
(7)	6.796000E-06	1.149000E-05	9.796000E-06	-7.090000E-03	-8.927000E-07
(8)	-1.114000E-02	6.338000E-05	-1.017000E-03	-2.104000E-04	-.117800
(9)	-6.592000E-04	1.298000E-03	9.520000E-04	-3.270000E-05	2.352000E-02
(10)	4.838000E-03	-1.902000E-03	1.847000E-04	8.906000E-05	.119700
(11)	-2.422000E-06	1.983000E-06	2.357000E-06	-2.665000E-03	-9.102000E-07
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)	(19)	(20)
(1)	-1.854000E-06	0.00000	0.00000	0.00000	0.00000
(2)	3.178000E-04	0.00000	0.00000	0.00000	0.00000
(3)	8.974000E-05	0.00000	0.00000	0.00000	0.00000
(4)	3.364000E-04	0.00000	0.00000	0.00000	0.00000
(5)	-2.456000E-07	0.00000	0.00000	0.00000	0.00000
(6)	1.519000E-06	0.00000	0.00000	0.00000	0.00000
(7)	-2.431000E-04	0.00000	0.00000	0.00000	0.00000
(8)	-.176900	0.00000	0.00000	0.00000	0.00000
(9)	3.307000E-02	0.00000	0.00000	0.00000	0.00000
(10)	.180300	0.00000	0.00000	0.00000	0.00000
(11)	2.451000E-04	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08
(13)	0.00000	0.00000	1.047000E-03	7.331000E-04	1.210000E-04
(14)	0.00000	0.00000	0.00000	2.003000E-03	1.441000E-04
(15)	0.00000	0.00000	0.00000	0.00000	6.944000E-03
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(21)	(22)	(23)	(24)	(25)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	-4.708000E-05	-8.282000E-07	-3.625000E-04	-9.888000E-04	8.859000E-07
(13)	1.119000E-07	-5.856000E-04	3.905000E-06	2.133000E-07	-3.964000E-04
(14)	2.213000E-07	1.157000E-03	-1.515000E-05	5.812000E-06	-5.932000E-03
(15)	6.791000E-08	-5.553000E-04	5.403000E-06	-1.500000E-06	8.518000E-04
(16)	6.921000E-03	-2.199000E-06	-6.851000E-04	-2.577000E-03	1.731000E-06

Matrix C_p (cont'd):

	(26)	(27)	(28)	(29)	(30)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	-1.407000E-06	-4.329000E-06	-1.326000E-05	-1.198000E-05	9.650000E-03
(13)	-3.743000E-04	-5.918000E-03	-2.589000E-03	-8.461000E-04	-1.270000E-04
(14)	3.110000E-03	2.746000E-04	-6.272000E-04	8.006000E-04	-4.746000E-05
(15)	1.688000E-05	4.838000E-03	-1.902000E-03	1.847000E-04	8.906000E-05
(16)	-8.184000E-07	-2.422000E-06	1.983000E-06	2.357000E-06	-2.665000E-03

	(31)	(32)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	0.00000	0.00000
(11)	0.00000	0.00000
(12)	1.817000E-06	-1.854000E-06
(13)	-5.308000E-04	3.178000E-04
(14)	-1.342000E-04	8.974000E-05
(15)	.119700	.180300
(16)	-9.102000E-07	2.451000E-04

MATRIX B FROM FILE DZME , BLOCKNO. 1, MATRIXNO. 5
DIMENSION 7X32, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	-4.708000E-05
(2)	0.00000	1.047000E-03	7.331000E-04	1.210000E-04	1.119000E-07
(3)	0.00000	0.00000	2.003000E-03	1.441000E-04	2.213000E-07
(4)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	1.409944E-02
(5)	0.00000	1.047000E-03	7.331000E-04	-1.334689E-02	-1.981145E-08
(6)	0.00000	0.00000	0.00000	6.944000E-03	6.791000E-08
(7)	0.00000	0.00000	0.00000	0.00000	6.921000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	-8.282000E-07	-3.625000E-04	-9.888000E-04	8.859000E-07	-1.407000E-06
(2)	-5.856000E-04	3.905000E-06	2.133000E-07	-3.964000E-04	-3.743000E-04
(3)	1.157000E-03	-1.515000E-05	5.812000E-06	-5.932000E-03	3.110000E-03
(4)	2.753920E-07	-6.172822E-05	-3.944734E-04	-1.263374E-06	5.800003E-07
(5)	2.544876E-04	-2.042872E-06	3.548181E-07	-2.841551E-04	1.271413E-04
(6)	-5.553000E-04	5.403000E-06	-1.500000E-06	8.518000E-04	1.688000E-05
(7)	-2.199000E-06	-6.851000E-04	-2.577000E-03	1.731000E-06	-8.184000E-07

	(11)	(12)	(13)	(14)	(15)
(1)	-4.329000E-06	-1.326000E-05	-1.198000E-05	9.650000E-03	1.817000E-06
(2)	-5.918000E-03	-2.589000E-03	-8.461000E-04	-1.270000E-04	-5.308000E-04
(3)	2.746000E-04	-6.272000E-04	8.006000E-04	-4.746000E-05	-1.342000E-04
(4)	-6.742440E-07	-4.608080E-07	-8.142807E-08	1.297383E-05	1.486118E-08
(5)	1.785746E-04	-1.631880E-04	5.795935E-05	5.536383E-07	6.077598E-03
(6)	4.838000E-03	-1.902000E-03	1.847000E-04	8.906000E-05	.119700
(7)	-2.422000E-06	1.983000E-06	2.357000E-06	-2.665000E-03	-9.102000E-07

	(16)	(17)	(18)	(19)	(20)
(1)	-1.854000E-06	0.00000	0.00000	0.00000	0.00000
(2)	3.178000E-04	0.00000	0.00000	0.00000	0.00000
(3)	8.974000E-05	0.00000	0.00000	0.00000	0.00000
(4)	1.350631E-06	0.00000	0.00000	0.00000	0.00000
(5)	9.152542E-03	0.00000	0.00000	0.00000	0.00000
(6)	.180300	0.00000	0.00000	0.00000	0.00000
(7)	2.451000E-04	0.00000	0.00000	0.00000	0.00000

	(21)	(22)	(23)	(24)	(25)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000

	(26)	(27)	(28)	(29)	(30)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000

	(31)	(32)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000

Matrix B_d :

MATRIX C FROM FILE DZME , BLOCKNO. 1, MATRIXNO. 6
DIMENSION 32*15, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	9.094000E-04	0.00000	0.00000	0.00000	0.00000
(18)	-3.859000E-07	1.047000E-03	0.00000	0.00000	0.00000
(19)	-9.257000E-07	7.331000E-04	2.003000E-03	0.00000	0.00000
(20)	-9.174000E-08	1.210000E-04	1.441000E-04	6.944000E-03	0.00000
(21)	-4.708000E-05	1.119000E-07	2.213000E-07	6.791000E-08	6.921000E-03
(22)	-8.282000E-07	-5.856000E-04	1.157000E-03	-5.553000E-04	-2.199000E-06
(23)	-3.625000E-04	3.905000E-06	-1.515000E-05	5.403000E-06	-6.851000E-04
(24)	-9.888000E-04	2.133000E-07	5.812000E-06	-1.500000E-06	-2.577000E-03
(25)	8.859000E-07	-3.964000E-04	-5.932000E-03	8.518000E-04	1.731000E-06
(26)	-1.407000E-06	-3.743000E-04	3.110000E-03	1.688000E-05	-8.184000E-07
(27)	-4.329000E-06	-5.918000E-03	2.746000E-04	4.838000E-03	-2.422000E-06
(28)	-1.326000E-05	-2.589000E-03	-6.272000E-04	-1.902000E-03	1.983000E-06
(29)	-1.198000E-05	-8.461000E-04	8.006000E-04	1.847000E-04	2.357000E-06
(30)	9.650000E-03	-1.270000E-04	-4.746000E-05	8.906000E-05	-2.665000E-03
(31)	1.817000E-06	-5.308000E-04	-1.342000E-04	.119700	-9.102000E-07
(32)	-1.854000E-06	3.178000E-04	8.974000E-05	.180300	2.451000E-04

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	5.729000E-03	-5.729000E-03	-5.729000E-03	5.729000E-03	-2.869000E-02
(18)	3.806000E-03	3.811000E-03	-3.806000E-03	-3.811000E-03	-1.906000E-02
(19)	1.022000E-02	-7.078000E-03	7.133000E-03	-1.027000E-02	9.299000E-03
(20)	1.289000E-03	4.539000E-05	-4.112000E-05	-1.293000E-03	-2.675000E-04
(21)	-8.075000E-04	8.081000E-04	8.094000E-04	-8.100000E-04	9.735000E-04
(22)	6.530000E-03	-3.478000E-03	3.488000E-03	-6.539000E-03	-1.039000E-02
(23)	1.044000E-03	-1.055000E-03	-1.175000E-03	1.186000E-03	-6.580000E-03
(24)	-3.368000E-03	3.370000E-03	3.419000E-03	-3.421000E-03	1.806000E-02
(25)	-2.485000E-02	2.639000E-02	-2.653000E-02	2.499000E-02	4.926000E-06
(26)	1.358000E-02	-1.328000E-02	1.336000E-02	-1.365000E-02	-1.654000E-04
(27)	-6.475000E-04	-3.014000E-03	3.025000E-03	6.358000E-04	-4.750000E-03
(28)	-3.328000E-03	2.101000E-03	-2.103000E-03	3.331000E-03	8.199000E-03
(29)	2.623000E-03	-4.293000E-03	4.310000E-03	-2.641000E-03	4.896000E-04
(30)	4.183000E-03	-4.251000E-03	-4.594000E-03	4.662000E-03	6.010000E-03
(31)	-5.342000E-04	6.243000E-04	-6.283000E-04	5.383000E-04	-5.333000E-04
(32)	3.438000E-04	-3.829000E-04	4.334000E-04	-3.943000E-04	1.487000E-03

Matrix B_d (cont'd) :

SPAR

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	2.869000E-02	2.869000E-02	-2.869000E-02	-9.961000E-04	-2.056000E-02
(18)	-1.908000E-02	1.906000E-02	1.908000E-02	1.348000E-05	-4.334000E-06
(19)	9.284000E-03	-9.299000E-03	-9.284000E-03	1.016000E-05	1.178000E-05
(20)	-2.702000E-04	2.675000E-04	2.702000E-04	1.609000E-06	5.650000E-07
(21)	-9.725000E-04	-9.735000E-04	9.725000E-04	2.016000E-04	9.142000E-04
(22)	-1.027000E-02	1.039000E-02	1.027000E-02	-3.738000E-05	-4.453000E-05
(23)	6.696000E-03	6.580000E-03	-6.696000E-03	-5.527000E-03	-1.441000E-02
(24)	-1.806000E-02	-1.806000E-02	1.806000E-02	-4.209000E-03	-4.400000E-02
(25)	2.497000E-05	-4.926000E-06	-2.497000E-05	5.252000E-06	1.324000E-05
(26)	-1.687000E-04	1.654000E-04	1.687000E-04	-1.037000E-05	-3.187000E-06
(27)	-4.745000E-03	4.750000E-03	4.745000E-03	-6.496000E-05	-7.288000E-07
(28)	8.225000E-03	-8.199000E-03	-8.225000E-03	-3.301000E-05	8.640000E-06
(29)	5.119000E-04	-4.896000E-04	-5.119000E-04	-1.590000E-05	7.127000E-06
(30)	-5.971000E-03	-6.010000E-03	5.971000E-03	6.523000E-04	-3.700000E-03
(31)	-5.333000E-04	5.333000E-04	5.333000E-04	-1.096000E-06	-1.229000E-07
(32)	1.410000E-03	-1.487000E-03	-1.410000E-03	-5.202000E-06	-1.770000E-05

APPENDIX G

DESIGN MODEL SYSTEM MATRICES FOR TRACKING PROBLEM

This appendix contains the data for the design model obtained from Appendix F by truncating seven (4,5,7,8,9,10,11) of the eleven elastic modes.

Matrix A_c :

MATRIX A FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 1
DIMENSION 18X18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	0.00000	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	1.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	-1.546280E-02	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	-2.285538E-02	0.00000	0.00000	0.00000
(17)	0.00000	0.00000	-5.737217E-02	0.00000	0.00000
(18)	0.00000	0.00000	0.00000	-.607833	0.00000

SPAR

Matrix A_c (cont'd) :

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	1.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	1.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	1.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	1.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	1.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	-1.846000E-03
(16)	0.00000	0.00000	0.00000	0.00000	5.509000E-06
(17)	0.00000	0.00000	0.00000	0.00000	-2.519000E-06
(18)	0.00000	0.00000	0.00000	0.00000	-3.255000E-03

	(16)	(17)	(18)
(1)	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000
(7)	1.00000	0.00000	0.00000
(8)	0.00000	1.00000	0.00000
(9)	0.00000	0.00000	1.00000
(10)	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000
(12)	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000
(15)	5.509000E-06	-2.519000E-06	-3.255000E-03
(16)	-1.706000E-03	-3.644000E-04	2.771000E-05
(17)	-3.644000E-04	-3.409000E-03	-1.146000E-05
(18)	2.771000E-05	-1.146000E-05	-4.215000E-02

SPAR

Matrix B_c :

MATRIX B FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 2
DIMENSION 18X 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	-1.145800E-02	0.00000
(11)	0.00000	0.00000	7.617000E-03	5.000009E-06	0.00000
(12)	0.00000	0.00000	3.142000E-03	5.500019E-05	1.735300E-02
(13)	6.944000E-03	0.00000	1.334390E-03	4.269999E-06	1.247880E-03
(14)	6.791000E-08	6.921000E-03	6.000046E-07	1.617500E-03	1.899985E-06
(15)	-5.553000E-04	-2.199000E-06	3.052000E-03	9.999989E-06	1.001800E-02
(16)	5.403000E-06	-6.851000E-04	-1.100000E-05	-2.230000E-03	-1.310000E-04
(17)	-1.500000E-06	-2.577000E-03	1.999986E-06	6.789000E-03	5.099998E-05
(18)	4.838000E-03	-2.422000E-06	-3.661500E-03	1.100003E-05	2.377500E-03

	(6)	(7)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	-2.869000E-02	2.869000E-02
(11)	-1.906000E-02	-1.908000E-02
(12)	9.299000E-03	9.284000E-03
(13)	-2.675000E-04	-2.702000E-04
(14)	9.735000E-04	-9.725000E-04
(15)	-1.039000E-02	-1.027000E-02
(16)	-6.580000E-03	6.696000E-03
(17)	1.806000E-02	-1.806000E-02
(18)	-4.750000E-03	-4.745000E-03

Matrix C_c :

MATRIX C FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 3
DIMENSION 16*18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	-4.708000E-05
(2)	0.00000	1.047000E-03	7.331000E-04	1.210000E-04	1.119000E-07
(3)	0.00000	0.00000	2.003000E-03	1.441000E-04	2.213000E-07
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	6.944000E-03	6.791000E-08
(11)	0.00000	0.00000	0.00000	0.00000	6.921000E-03
(12)	0.00000	0.00000	0.00000	0.00000	0.00000
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

	(6)	(7)	(8)	(9)	(10)
(1)	-8.282000E-07	-3.625000E-04	-9.888000E-04	-4.329000E-06	0.00000
(2)	-5.856000E-04	3.905000E-06	2.133000E-07	-5.918000E-03	0.00000
(3)	1.157000E-03	-1.515000E-05	5.812000E-06	2.746000E-04	0.00000
(4)	-1.756000E-03	1.504000E-05	-3.172000E-06	-6.200000E-03	0.00000
(5)	-2.418000E-06	-5.987000E-04	-5.019000E-04	-4.426000E-06	0.00000
(6)	2.208000E-06	6.242000E-04	1.617000E-03	3.638000E-06	0.00000
(7)	4.200000E-06	1.211000E-03	3.425000E-03	6.796000E-06	0.00000
(8)	5.736000E-05	-2.287000E-06	1.776000E-06	-1.114000E-02	0.00000
(9)	3.335000E-03	-3.071000E-05	8.002000E-06	-6.592000E-04	0.00000
(10)	-5.553000E-04	5.403000E-06	-1.500000E-06	4.838000E-03	0.00000
(11)	-2.199000E-06	-6.851000E-04	-2.577000E-03	-2.422000E-06	0.00000
(12)	0.00000	0.00000	0.00000	0.00000	9.094000E-04
(13)	0.00000	0.00000	0.00000	0.00000	0.00000
(14)	0.00000	0.00000	0.00000	0.00000	0.00000
(15)	0.00000	0.00000	0.00000	0.00000	0.00000
(16)	0.00000	0.00000	0.00000	0.00000	0.00000

Matrix C_c (cont'd):

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000	0.00000	0.00000
(12)	-3.859000E-07	-9.257000E-07	-9.174000E-08	-4.708000E-05	-8.282000E-07
(13)	1.047000E-03	7.331000E-04	1.210000E-04	1.119000E-07	-5.856000E-04
(14)	0.00000	2.003000E-03	1.441000E-04	2.213000E-07	1.157000E-03
(15)	0.00000	0.00000	6.944000E-03	6.791000E-08	-5.553000E-04
(16)	0.00000	0.00000	0.00000	6.921000E-03	-2.199000E-06

	(16)	(17)	(18)
(1)	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000
(11)	0.00000	0.00000	0.00000
(12)	-3.625000E-04	-9.888000E-04	-4.329000E-06
(13)	3.905000E-06	2.133000E-07	-5.918000E-03
(14)	-1.515000E-05	5.812000E-06	2.746000E-04
(15)	5.403000E-06	-1.500000E-06	4.838000E-03
(16)	-6.851000E-04	-2.577000E-03	-2.422000E-06

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Matrix D_c :

MATRIX A FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 4
DIMENSION 7*18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	-4.708000E-05
(2)	0.00000	1.047000E-03	7.331000E-04	1.210000E-04	1.119000E-07
(3)	0.00000	0.00000	2.003000E-03	1.441000E-04	2.213000E-07
(4)	9.094000E-04	-3.859000E-07	-9.257000E-07	-9.174000E-08	1.409944E-02
(5)	0.00000	1.047000E-03	7.331000E-04	-1.334689E-02	-1.981145E-08
(6)	0.00000	0.00000	0.00000	6.944000E-03	6.791000E-08
(7)	0.00000	0.00000	0.00000	0.00000	6.921000E-03

	(6)	(7)	(8)	(9)	(10)
(1)	-8.282000E-07	-3.625000E-04	-9.888000E-04	-4.329000E-06	0.00000
(2)	-5.856000E-04	3.905000E-06	2.133000E-07	-5.918000E-03	0.00000
(3)	1.157000E-03	-1.515000E-05	5.812000E-06	2.746000E-04	0.00000
(4)	2.753920E-07	-6.172822E-05	-3.944734E-04	-6.742440E-07	0.00000
(5)	2.544876E-04	-2.042872E-06	3.548181E-07	1.785746E-04	0.00000
(6)	-5.553000E-04	5.403000E-06	-1.500000E-06	4.838000E-03	0.00000
(7)	-2.199000E-06	-6.851000E-04	-2.577000E-03	-2.422000E-06	0.00000

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000

	(16)	(17)	(18)
(1)	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000

Matrix B_{d_c} :

MATRIX B FROM FILE DZMD , BLOCKNO. 5, MATRIXNO. 5
DIMENSION 18X15, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	9.094000E-04	0.00000	0.00000	0.00000	0.00000
(11)	-3.859000E-07	1.047000E-03	0.00000	0.00000	0.00000
(12)	-9.257000E-07	7.331000E-04	2.003000E-03	0.00000	0.00000
(13)	-9.174000E-08	1.210000E-04	1.441000E-04	6.944000E-03	0.00000
(14)	-4.708000E-05	1.119000E-07	2.213000E-07	6.791000E-08	6.921000E-03
(15)	-8.282000E-07	-5.856000E-04	1.157000E-03	-5.553000E-04	-2.199000E-06
(16)	-3.625000E-04	3.905000E-06	-1.515000E-05	5.403000E-06	-6.851000E-04
(17)	-9.888000E-04	2.133000E-07	5.812000E-06	-1.500000E-06	-2.577000E-03
(18)	-4.329000E-06	-5.918000E-03	2.746000E-04	4.838000E-03	-2.422000E-06

	(6)	(7)	(8)	(9)	(10)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	5.729000E-03	-5.729000E-03	-5.729000E-03	5.729000E-03	-2.869000E-02
(11)	3.806000E-03	3.811000E-03	-3.806000E-03	-3.811000E-03	-1.906000E-02
(12)	1.022000E-02	-7.078000E-03	7.133000E-03	-1.027000E-02	9.299000E-03
(13)	1.289000E-03	4.539000E-05	-4.112000E-05	-1.293000E-03	-2.675000E-04
(14)	-8.075000E-04	8.081000E-04	8.094000E-04	-8.100000E-04	9.735000E-04
(15)	6.530000E-03	-3.478000E-03	3.488000E-03	-6.539000E-03	-1.039000E-02
(16)	1.044000E-03	-1.055000E-03	-1.175000E-03	1.186000E-03	-6.580000E-03
(17)	-3.368000E-03	3.370000E-03	3.419000E-03	-3.421000E-03	1.806000E-02
(18)	-6.475000E-04	-3.014000E-03	3.025000E-03	6.358000E-04	-4.750000E-03

	(11)	(12)	(13)	(14)	(15)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	2.869000E-02	2.869000E-02	-2.869000E-02	-9.961000E-04	-2.056000E-02
(11)	-1.908000E-02	1.906000E-02	1.908000E-02	1.348000E-05	-4.334000E-06
(12)	9.284000E-03	-9.299000E-03	-9.284000E-03	1.016000E-05	1.178000E-05
(13)	-2.702000E-04	2.675000E-04	2.702000E-04	1.609000E-06	5.650000E-07
(14)	-9.725000E-04	-9.735000E-04	9.725000E-04	2.016000E-04	9.142000E-04
(15)	-1.027000E-02	1.039000E-02	1.027000E-02	-3.738000E-05	-4.453000E-05
(16)	6.696000E-03	6.580000E-03	-6.696000E-03	-5.527000E-03	-1.441000E-02
(17)	-1.806000E-02	-1.806000E-02	1.806000E-02	-4.209000E-03	-4.400000E-02
(18)	-4.745000E-03	4.750000E-03	4.745000E-03	-6.496000E-05	-7.288000E-07

APPENDIX H

NOMINAL VALUES FOR TRACKING COMPENSATOR PARAMETERS

Listed below are the nominal values for the tracking compensator of Sec. 4 for the case $\rho = 1.0E3$.

Matrix $F_{\parallel}$:

MATRIX A FROM FILE DZMD5 , BLOCKNO. 3, MATRIXNO. 1
DIMENSION 7X18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	2.513905E-05	-1.34166	-1.03296	18.8461	-1.115160E-04
(2)	1.03254	-8.391212E-04	-1.659591E-03	-2.949905E-04	19.3221
(3)	4.517376E-05	.795870	.588831	1.66487	2.367040E-04
(4)	-.146601	1.522443E-03	2.967451E-03	5.126325E-04	2.55731
(5)	5.090395E-04	.556555	1.02105	.251420	1.785934E-03
(6)	-.812261	-.857107	-.277266	2.08822	-2.13657
(7)	.811689	-.856906	-.277976	2.08820	2.13745

	(6)	(7)	(8)	(9)	(10)
(1)	-.318203	2.378773E-03	-2.725236E-04	1.992004E-02	-1.248932E-03
(2)	-1.266378E-04	-.135671	-.226548	-4.222363E-05	2.66990
(3)	-7.069889E-02	-4.173664E-04	-7.665715E-05	-3.883579E-02	1.219721E-02
(4)	-7.476149E-05	-8.159918E-02	.160092	2.602836E-04	-.689405
(5)	8.128544E-02	-3.230221E-03	1.218477E-03	9.093879E-03	-3.318402E-03
(6)	-.101614	-.159463	.486183	-6.887800E-03	-6.23590
(7)	-9.967268E-02	.161689	-.485928	-6.861843E-03	6.23453

	(11)	(12)	(13)	(14)	(15)
(1)	-4.21504	-4.02620	72.6678	-1.482697E-03	-1.95378
(2)	-6.050203E-03	-9.501806E-03	1.302756E-04	72.7364	2.500650E-04
(3)	7.98695	6.11167	6.79420	4.066852E-03	-3.84528
(4)	1.775918E-02	3.395981E-02	-4.832052E-03	11.6837	6.650348E-03
(5)	5.66746	10.6639	5.763060E-02	-9.664494E-03	-.614237
(6)	-8.54059	-2.35978	6.53229	-6.05072	2.96798
(7)	-8.53490	-2.36271	6.53014	6.05944	2.96342

	(16)	(17)	(18)
(1)	1.269152E-02	-5.140363E-03	.161574
(2)	-.987256	-2.27761	-1.155959E-03
(3)	3.857092E-02	1.274025E-02	-.756161
(4)	1.81469	2.25926	5.945229E-03
(5)	-1.694749E-02	-1.582199E-02	.182302
(6)	-.560326	-.427243	-.177453
(7)	.533195	.446128	-.175964

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Matrix F_2 :

MATRIX B FROM FILE DZMD5 , BLOCKNO. 3, MATRIXNO. 2
DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	3.058505E-02	-1.46801	-1.92190	-2.910395E-02	-170.620
(2)	-4.10308	2.462890E-02	-8.167261E-03	167.617	-3.814113E-02
(3)	-.159040	56.5398	.377887	.145983	-24.6243
(4)	-41.1883	-.167453	4.234132E-02	41.7122	.236353
(5)	.175642	10.2792	15.1635	-.126986	13.6551
(6)	-31.1819	-13.0677	6.86915	-38.6068	-38.2694
(7)	31.0149	-13.1241	6.87925	38.7562	-38.2020

	(6)	(7)
(1)	19.2298	5.765465E-02
(2)	-7.772011E-02	22.5609
(3)	-19.5393	-.281574
(4)	.465468	-41.9229
(5)	31.0848	.296193
(6)	-31.1332	26.1270
(7)	-30.9882	-26.4251

Matrix $H_c^{-1}(0)$:

MATRIX C FROM FILE DZMD5 , BLOCKNO. 3, MATRIXNO. 3
DIMENSION 7* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	6.63525	-1560.18	-46.7007	-6.60761	278.753
(2)	3885.53	37.6421	-.163651	-2750.13	-38.0251
(3)	-33.1437	8642.40	15.7612	33.1934	-7882.26
(4)	-23027.9	-219.523	.896545	22866.7	220.918
(5)	86.6556	-3786.43	315.206	-86.0958	4318.01
(6)	4035.91	3760.54	160.902	-4929.09	-4579.50
(7)	-4071.95	3679.52	161.062	4964.51	-4497.63

	(6)	(7)
(1)	3277.95	13.4854
(2)	-73.7671	8420.80
(3)	-15061.5	-67.8278
(4)	428.499	-46371.1
(5)	8395.17	176.223
(6)	-8570.30	9760.28
(7)	-8411.52	-9832.54

Matrix $(A_c - K C_c)$:

MATRIX A FROM FILE DZMD5 , BLOCKNO.12, MATRIXNO. 1
DIMENSION 18*18, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	-9.536979E-02	2.038538E-05	1.707523E-05	-1.372627E-06	2.138375E-02
(2)	7.442281E-06	-8.267517E-02	8.754368E-03	-4.290339E-03	4.507491E-06
(3)	-1.800203E-05	3.069713E-03	-9.384776E-02	-2.418482E-03	1.062845E-06
(4)	1.278326E-07	-8.747267E-04	-7.620635E-04	-9.643601E-02	5.305408E-08
(5)	8.564010E-04	3.384868E-07	-4.201207E-06	-1.217038E-08	-9.164195E-02
(6)	-6.846681E-05	-5.406067E-03	-4.513138E-03	2.461922E-03	1.042644E-04
(7)	-6.297046E-03	-3.602120E-05	3.920515E-05	6.185298E-06	1.362083E-02
(8)	3.969211E-03	1.475292E-05	-1.819774E-05	-1.694593E-06	1.430938E-02
(9)	2.778969E-07	5.218815E-04	3.614924E-04	-1.011383E-03	4.094718E-07
(10)	-7.288974E-03	3.012734E-06	1.061686E-05	-3.556545E-06	4.927172E-03
(11)	1.388033E-06	-4.090085E-03	1.591138E-03	-2.101828E-04	-3.429073E-07
(12)	-5.407172E-07	1.015488E-04	-7.021071E-03	-6.279823E-04	-5.249071E-06
(13)	8.417843E-09	-1.109785E-04	-1.366202E-04	-7.534364E-03	8.088849E-08
(14)	1.699925E-04	4.770110E-09	-1.441511E-06	6.289355E-07	-6.109340E-03
(15)	-2.412555E-06	-1.908790E-04	-5.840699E-04	4.545690E-04	2.788596E-06
(16)	-4.359859E-05	-4.150068E-06	1.918751E-05	-1.471672E-05	1.387000E-03
(17)	4.573921E-04	3.895270E-07	-8.774409E-06	6.090912E-06	6.220664E-03
(18)	2.840278E-08	8.540105E-05	3.756483E-05	-2.203357E-04	1.013981E-07

	(6)	(7)	(8)	(9)	(10)
(1)	-2.256801E-04	-5.868235E-02	-.149051	-2.137942E-04	.278652
(2)	-.232437	2.045525E-03	-5.040435E-04	.176638	3.167861E-04
(3)	7.557266E-02	-4.669389E-04	6.779840E-05	7.551152E-02	-6.552106E-04
(4)	-6.028975E-03	5.547906E-05	-9.577287E-06	-5.859864E-02	4.473612E-05
(5)	-8.063317E-05	-2.212447E-02	-4.900511E-02	-5.146863E-05	2.197108E-02
(6)	-.229482	1.765391E-03	-1.150701E-03	-.142149	-1.687645E-03
(7)	8.933073E-04	-5.441432E-02	-.121816	-9.919700E-04	-.194931
(8)	-3.698296E-04	-7.718293E-02	-.213487	1.409844E-04	.122312
(9)	-5.460641E-03	4.203689E-05	-1.355534E-05	-3.335368E-02	-1.242323E-05
(10)	3.204372E-05	-8.047146E-03	-1.998047E-02	-1.124006E-04	-.302097
(11)	-5.871421E-02	5.192344E-04	-1.274462E-04	-5.493779E-02	1.042793E-04
(12)	1.732991E-02	-1.317537E-04	4.541288E-05	2.704815E-02	-4.631362E-05
(13)	-1.762864E-03	1.599614E-05	-3.913655E-06	-5.780187E-03	1.654138E-05
(14)	-2.389990E-05	-3.654167E-03	-9.011830E-03	-1.795900E-05	1.582120E-02
(15)	-4.819135E-02	2.862532E-04	-8.285777E-05	-4.075409E-02	-5.949698E-04
(16)	3.751071E-04	-2.632038E-02	-8.833570E-03	2.735276E-04	-6.172927E-02
(17)	-1.507001E-04	-1.165557E-02	-8.873053E-02	-1.250329E-04	.140401
(18)	4.103662E-04	-4.287731E-06	2.390353E-07	-.608872	3.356046E-05

Matrix $(A_c - KC_c)$ (cont'd):

	(11)	(12)	(13)	(14)	(15)
(1)	4.022544E-04	-1.454753E-04	5.861465E-04	.131316	-1.937614E-05
(2)	.265327	.105472	.315183	2.214898E-03	.740548
(3)	.143146	.323895	-.121778	3.348292E-03	-.521906
(4)	-1.325943E-02	-1.206046E-02	.203869	-1.051223E-04	6.933921E-02
(5)	-4.701507E-05	5.926209E-05	-2.347579E-04	.130672	3.581851E-04
(6)	-.250456	-.106893	.126123	1.413661E-02	1.16763
(7)	1.220338E-03	-3.959353E-03	4.229643E-03	1.38440	-4.111856E-03
(8)	-2.341827E-04	1.198530E-03	-1.833530E-03	-.403729	1.107077E-03
(9)	-9.749972E-03	1.571805E-04	4.914084E-02	6.416785E-05	5.507837E-03
(10)	3.004427E-04	1.695273E-03	-4.122454E-04	.168862	9.063351E-04
(11)	-.112436	6.110627E-02	6.557772E-02	4.238437E-04	.138180
(12)	1.880727E-02	-.239916	-8.607121E-02	-1.521222E-04	-.151109
(13)	-5.984627E-03	-1.223751E-02	-.320682	8.199541E-06	2.424178E-02
(14)	-1.820814E-05	-1.617026E-04	1.968666E-05	-.240036	-1.402603E-05
(15)	-4.485352E-02	-6.297620E-02	5.421666E-02	9.255914E-04	7.352067E-05
(16)	1.364249E-04	1.810169E-03	-6.226979E-04	.321608	9.245614E-04
(17)	-1.468450E-04	-1.612470E-03	4.729745E-04	1.64480	-1.467916E-03
(18)	5.701423E-02	3.608580E-02	-.293344	2.025702E-04	-1.339601E-02

	(16)	(17)	(18)
(1)	.278246	.749337	3.125011E-03
(2)	-7.499891E-03	3.945218E-04	4.48528
(3)	6.267690E-03	-2.753888E-03	-.972997
(4)	-6.551576E-04	1.469468E-04	-.478905
(5)	7.718178E-02	.299377	2.626945E-04
(6)	-2.054969E-03	-3.287547E-03	1.52967
(7)	.941707	-.299780	-3.572546E-03
(8)	-9.430674E-03	1.01498	-5.408719E-04
(9)	-5.178255E-05	-2.535810E-06	1.09074
(10)	.105244	.271426	1.987251E-04
(11)	-1.507341E-03	9.635726E-05	.702427
(12)	1.961019E-03	-6.174294E-04	-.189797
(13)	-2.179343E-04	2.133838E-05	-.189816
(14)	1.737424E-02	7.186839E-02	7.716199E-05
(15)	2.728218E-04	1.943018E-04	.288916
(16)	-8.631774E-03	-5.179957E-02	-7.147320E-04
(17)	-.219855	-.771212	-5.407610E-04
(18)	2.874465E-06	-5.778617E-05	-.573716

Matrix K :

MATRIX B FROM FILE DZMD5 , BLOCKNO.12, MATRIXNO. 2
DIMENSION 18*16, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	104.871	1.918279E-02	3.292114E-02	-1.547234E-03	-15.2389
(2)	-8.183727E-03	78.9639	-33.2715	-43.1510	-2.351612E-02
(3)	1.979551E-02	-2.93191	47.9267	17.3574	-5.211349E-02
(4)	-1.405681E-04	.835460	7.468176E-02	-1.36579	2.064224E-03
(5)	-.941721	-6.703886E-04	1.907598E-03	3.804121E-03	-3.12174
(6)	7.528789E-02	5.16342	.363409	-30.0784	-.233267
(7)	6.92440	3.695637E-02	-2.989913E-02	7.555678E-02	-26.3056
(8)	-4.36465	-1.569936E-02	1.281407E-02	1.574986E-02	-2.24517
(9)	-3.055827E-04	-.498454	1.959131E-03	-1.52578	-8.450749E-04
(10)	8.01515	7.670596E-05	-1.624301E-03	3.617999E-03	-2.55729
(11)	-1.526317E-03	3.90648	-2.22415	-9.25739	-3.566112E-03
(12)	5.945867E-04	-9.699003E-02	3.54078	3.19651	-7.339092E-04
(13)	-9.256480E-06	.105997	2.941289E-02	-.289270	4.470178E-05
(14)	-.186928	-7.345340E-05	6.601700E-04	-8.739335E-04	-.478317
(15)	2.652909E-03	.182311	.224873	-4.79926	-1.063977E-02
(16)	4.794215E-02	3.981441E-03	-1.101444E-02	4.801786E-02	-.792281
(17)	-.502960	-5.574206E-04	4.352204E-03	-1.282396E-02	-1.42348
(18)	-3.123243E-05	-8.156740E-02	1.109945E-02	3.457795E-02	-1.557505E-04

	(6)	(7)	(8)	(9)	(10)
(1)	27.6427	56.7233	-1.700099E-02	-1.712013E-02	5.657328E-04
(2)	-2.592247E-03	-1.219764E-02	-7.21607	72.4967	-6.766539E-02
(3)	-1.007483E-03	-1.650803E-02	1.42034	-30.7866	-.595189
(4)	-6.119201E-04	-7.827673E-04	.874887	3.50411	13.8716
(5)	9.11759	19.2321	7.014219E-03	1.246853E-03	-3.859316E-05
(6)	8.341095E-02	.119742	-2.12871	53.7142	-.452053
(7)	14.7586	25.2987	-.107430	-.269753	-8.227694E-04
(8)	22.3445	48.6155	5.079339E-02	3.102966E-02	1.940229E-04
(9)	6.381818E-04	1.172992E-03	-1.86056	.803481	.154294
(10)	2.98277	5.87015	-8.323560E-03	-1.653950E-02	6.504370E-04
(11)	1.462186E-04	-6.635217E-04	-2.74830	14.2373	8.352413E-03
(12)	-1.848529E-03	-4.271829E-03	1.07840	-4.77415	1.864808E-02
(13)	-2.454841E-05	-4.203720E-05	2.328115E-02	.564545	1.08256
(14)	1.23405	2.58772	7.858424E-04	2.545285E-03	-1.054618E-04
(15)	1.870430E-03	1.197621E-03	-1.53976	7.25494	-7.330539E-02
(16)	.950891	1.87768	3.319316E-03	-8.603872E-02	2.279168E-03
(17)	3.18217	6.62064	4.858220E-04	2.446190E-02	-9.643949E-04
(18)	9.736231E-05	1.718008E-04	-4.769089E-02	-.116714	3.292136E-02

	(11)	(12)	(13)	(14)	(15)	(16)
(1)	-2.37631	793.213	-9.183709E-02	.472830	-8.214280E-02	-13.5777
(2)	-9.191247E-04	-.348346	701.693	-309.477	-51.1942	-.323343
(3)	-1.498129E-03	.720487	-136.720	387.586	11.8764	-.489185
(4)	-1.606278E-04	-4.919301E-02	12.6642	1.38607	114.401	1.348266E-02
(5)	13.2347	-24.1600	3.599975E-02	-5.392831E-02	3.397991E-02	125.443
(6)	-1.464345E-02	1.85578	239.214	-34.1855	-21.6218	-2.03251
(7)	-1.92094	214.351	-1.08655	2.47345	-.638671	-198.570
(8)	-2.09722	-134.497	.174098	-.724246	.274264	57.4190
(9)	-5.475990E-05	1.366091E-02	9.31230	-3.48678	-7.16664	-9.147295E-03
(10)	-.657393	332.194	-.164517	-.632628	7.975074E-02	-22.1387
(11)	4.703817E-05	-.114668	107.388	-69.8116	-9.86634	-6.142749E-02
(12)	6.506397E-04	5.092767E-02	-17.9630	126.353	10.0860	1.847754E-02
(13)	-2.502689E-05	-1.818933E-02	5.71597	4.01753	45.9982	-1.980686E-03
(14)	.881453	-17.3974	1.097849E-02	6.867172E-02	-4.681263E-03	34.5640
(15)	-3.942904E-04	.654244	42.8403	15.7617	-8.88127	-.130396
(16)	-.200078	67.8791	-.105282	-.833825	.109709	-46.0066
(17)	-.902231	-154.389	8.334894E-02	.703170	-8.619674E-02	-238.704
(18)	-1.422239E-05	-3.690395E-02	-54.4549	1.91464	43.1534	-2.912418E-02

Matrix B_c :

MATRIX C FROM FILE DZMD5 , BLOCKNO.12, MATRIXNO. 3
DIMENSION 18* 7, SAMPLING TIME = .000

	(1)	(2)	(3)	(4)	(5)
(1)	0.00000	0.00000	0.00000	0.00000	0.00000
(2)	0.00000	0.00000	0.00000	0.00000	0.00000
(3)	0.00000	0.00000	0.00000	0.00000	0.00000
(4)	0.00000	0.00000	0.00000	0.00000	0.00000
(5)	0.00000	0.00000	0.00000	0.00000	0.00000
(6)	0.00000	0.00000	0.00000	0.00000	0.00000
(7)	0.00000	0.00000	0.00000	0.00000	0.00000
(8)	0.00000	0.00000	0.00000	0.00000	0.00000
(9)	0.00000	0.00000	0.00000	0.00000	0.00000
(10)	0.00000	0.00000	0.00000	-1.145800E-02	0.00000
(11)	0.00000	0.00000	7.617000E-03	5.000009E-06	0.00000
(12)	0.00000	0.00000	3.142000E-03	5.500019E-05	1.735300E-02
(13)	6.944000E-03	0.00000	1.334390E-03	4.269999E-06	1.247880E-03
(14)	6.791000E-08	6.921000E-03	6.000046E-07	1.617500E-03	1.899985E-06
(15)	-5.553000E-04	-2.199000E-06	3.052000E-03	9.999989E-06	1.001800E-02
(16)	5.403000E-06	-6.851000E-04	-1.100000E-05	-2.230000E-03	-1.310000E-04
(17)	-1.500000E-06	-2.577000E-03	1.999986E-06	6.789000E-03	5.099998E-05
(18)	4.838000E-03	-2.422000E-06	-3.661500E-03	1.100003E-05	2.377500E-03

	(6)	(7)
(1)	0.00000	0.00000
(2)	0.00000	0.00000
(3)	0.00000	0.00000
(4)	0.00000	0.00000
(5)	0.00000	0.00000
(6)	0.00000	0.00000
(7)	0.00000	0.00000
(8)	0.00000	0.00000
(9)	0.00000	0.00000
(10)	-2.869000E-02	2.869000E-02
(11)	-1.906000E-02	-1.908000E-02
(12)	9.299000E-03	9.284000E-03
(13)	-2.675000E-04	-2.702000E-04
(14)	9.735000E-04	-9.725000E-04
(15)	-1.039000E-02	-1.027000E-02
(16)	-6.580000E-03	6.696000E-03
(17)	1.806000E-02	-1.806000E-02
(18)	-4.750000E-03	-4.745000E-03

APPENDIX I

PROOF OF THEOREM 5-1

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PROOF OF THEOREM 5-1

It suffices to show that the return difference transfer function matrix for the evaluation model closed-loop system $(I+(P_R+P_C)H)$ is invertible and asymptotically stable. We can write

$$[I+(P_R+P_C)H]^{-1} = [I+P_CH]^{-1}[I+P_RH(I+P_CH)^{-1}]^{-1}. \qquad \text{(I-1)}$$

Since $[I+P_CH]^{-1}$ exists and is asymptotically stable by assumption, the left-hand side of (I-1) exists and is asymptotically stable if

$$[I+P_RH(I+P_CH)^{-1}]^{-1} := [I+P_RW]^{-1} \qquad \text{(I-2)}$$

exists and is asymptotically stable.

It is a well-known result in numerical analysis that if a matrix A is invertible, then $A + \Delta A$ is invertible provided

$$\bar{\sigma}(\Delta A) < \underline{\sigma}(A).$$

Extension of this result to (I-2) in the same spirit as Ref.[20] then proves the theorem.