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DYNAMIC CHARACTERISTICS OF INDUSTRIAL ROBOTS, USING SEGMENTED TRAJECTORIES

الخصائص الديناميكية لمنظومات الذراع الالى الصناعية ذات المسارات المجزاة

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ملخص البحث

تمثل منظومات الذراع الالى الصناعية واحدا من اهم التطبيقات المتقدمة فى مجالات التحكم الالى وهذه المنظومات ذات خصائص ديناميكية شديدة التذبذب بسبب توافر اللاخطيات فى اجزاء المنظومة . ولذلك فان اساليب التحكم التقليدية لاتصلح للتعامل مع امثال هذه المنظومات .

وفى هذا البحث تمت دراسة للخواص الديناميكية لهذه المنظومات بعد الحصول على نموذجها الرياضى ثم تم اقتراح مسار مناسب يتم تحديده مسبقا تختفى فيه ظاهرة التذبذب ومن هذا المسار يتم استنتاج العزم اللازم لتحريك الذراع .

وفى بعض الاحيان تكون هناك حاجة لاستخدام مسارات مجزاة مثل عمليات اللحام الكهربى ولقد تم اقتراح مسارات مجزاة لمنظومة ذراع الى ذات ثلاثة اذرع واستنتاج العزم اللازم لكل ذراع وذلك باستخدام المحاكاة على الحاسب الالى . والبحث يحتوى على دراسة مقارنة بين المعزوم فى حالة المسارات المستمرة والمسارات المجزاة .

ABSTRACT

Robotic systems represent one of the most advanced industrial applications. Such robotic systems have a severe oscillatory behaviour, thus the conventional control techniques are not suitable to deal with it . In the present paper, the dynamic behaviour of robotic systems is studied and a dynamic model for such systems is obtained. A suitable trajectory for each link is pre-determined. The technique introduced proposes a segmented trajectory rather than a continous one .
A comparative study between the behaviour of the system with the proposed technique and that proposed in [7] is introduced .

The above mentioned algorithm assumed that the chosen path is continuous and this can be used in some tasks, required to be carried-out by the robot. But in other tasks, it is sometimes required that the robot must move a short distance from a point to another neighbouring point i.e., the path is not continuous but , it is a segmented path. Such pathes are required in different tasks, such pathes are welding, paint spraying, carrying a tray of drink,.....etc.

DYNAMICS USING SEGMENTED TRAJECTORIES

The technique used for dividing the previous continuous trajectories into segmented trajectories can be explained as follows:

The base line is divided into equal intervals Δt. In our case Δt is chosen to be 0.1 sec.
Fig.(9),(a),(b),(c) illustrates the desired segmented trajectories for the three links (1),(2) & (3) respectively. The figure shows the desired joint pathes for a typical motion by straight lines approximation-(incremental and decremental steps).

Each segment on the trajectory has a begining and final condition. The final condition of the first segment is the begining condition of second segment and so-on,e.g.:

Forthe first segment:-

at t=0, $\theta_1(0)=0$, $\theta_2(0)=0.1$, $\theta_3(0)=0.2$

at t=0.1, $\theta_1(t)=0.01$, $\theta_2(t)=0.1$, $\theta_3(t)=0.2$

For the second segment:-

at t=0.1, $\theta(0)=0.1$, $\theta_2(0)=0.1$, $\theta_3(0)=0.2$

at t=0.2, $\theta_1(t)=0.06$, $\theta_2(t)=0.12$, $\theta_3(t)=0.22$

For the third segment:-

at t=0.2, $\theta_1(0)=0.06$, $\theta_2(0)=0.12$, $\theta_3(0)=0.22$

at t=0.3, $\theta_1(t)=0.17$, $\theta_2(t)=0.17$, $\theta_3(0)=0.25$ .....etc,.

The angular velocities of links (1),(2) & (3) respectively, using these segmented pathes are shown in Fig. (10),(a),(b) & (c)). The applied torques to links (1),(2) & (3) are shown in Fig, (11),(a),(b) & (c) respectively.

COMPARATIVE ANALYSIS:-

Comparing Fig. (8),(a),(b) & (c) with Fig.(11)(a),(b) & (c) it is clear that the torques produced by the actuators, in case of segmented trajectories have much regular change, than those torques obtained in case of continuous trajectories. The torques produced in case of continuous trajectories have an oscillatory behaviour. Thus, the torques shown in Fig.(11),((a),(b) & (c)) are much suitable for stable operation .In addition, it is clear that the motors producing these torques reach steady-state faster than those producing the torques shown in Fig.(8),((a),(b) & (c)).

CONCLUSIONS:-

In the present paper a suggested technique for assuming a segmented robot trajectory is introduced. The proposed segmented trajectory as illustrated aquired a torque with stable behaviour. The segmented trajectory of a robot is required in special fields of industry such as spot and arc welding.

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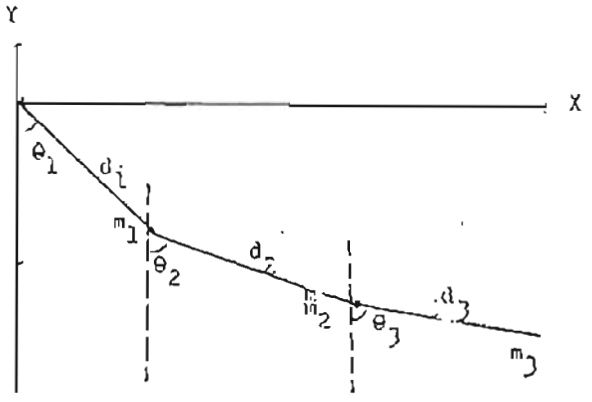
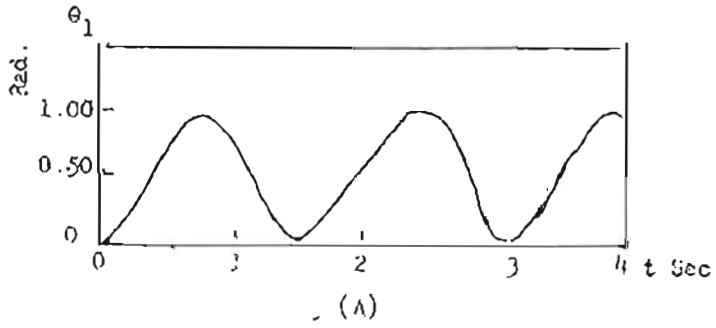
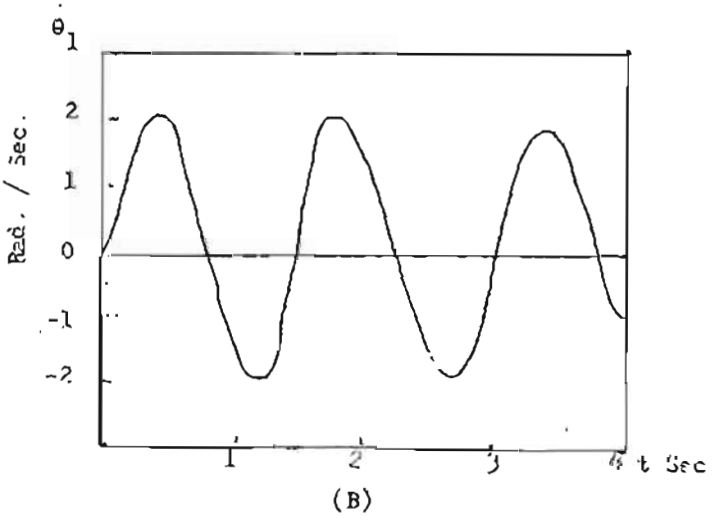


Figure (1)



(A)



(B)

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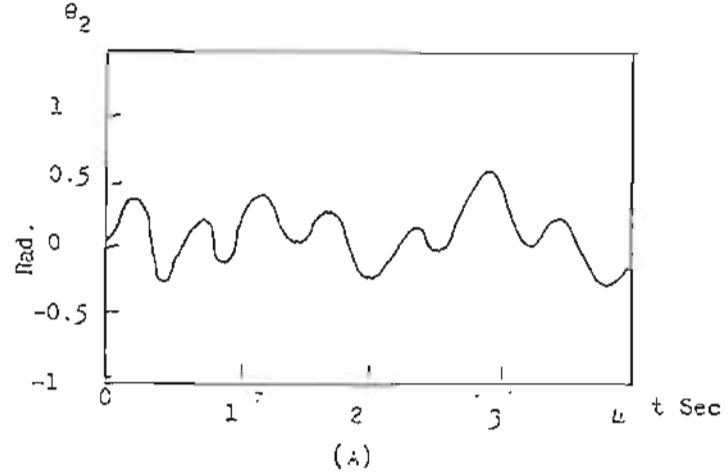
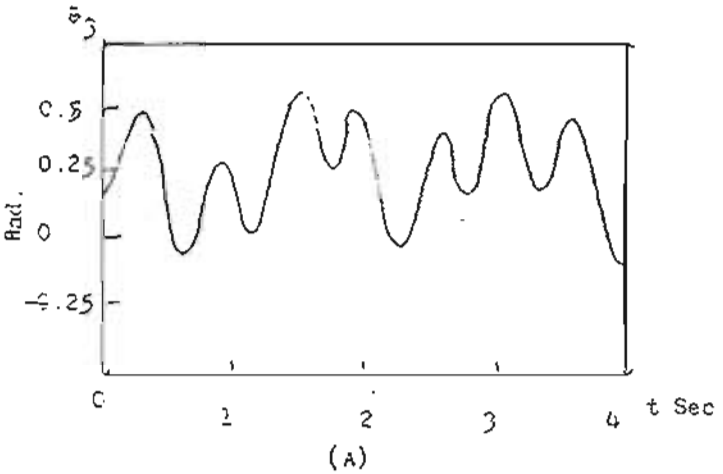


(A)



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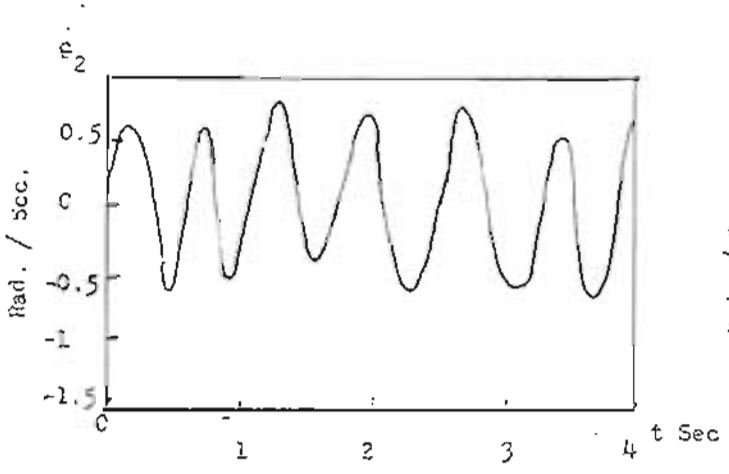

(B)

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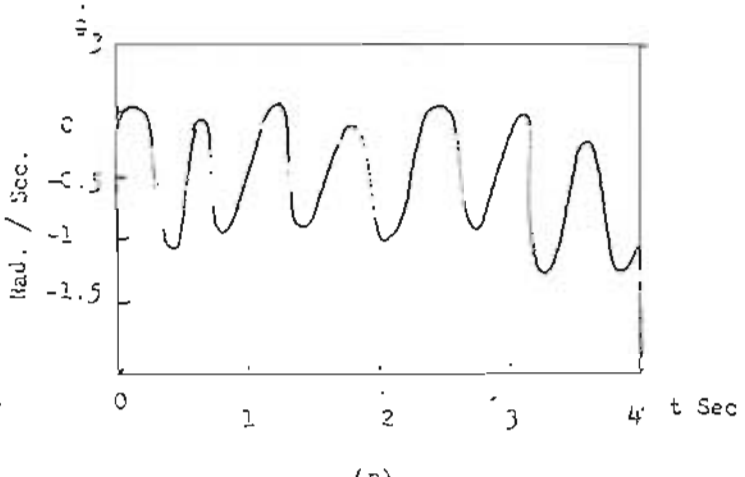

(B)

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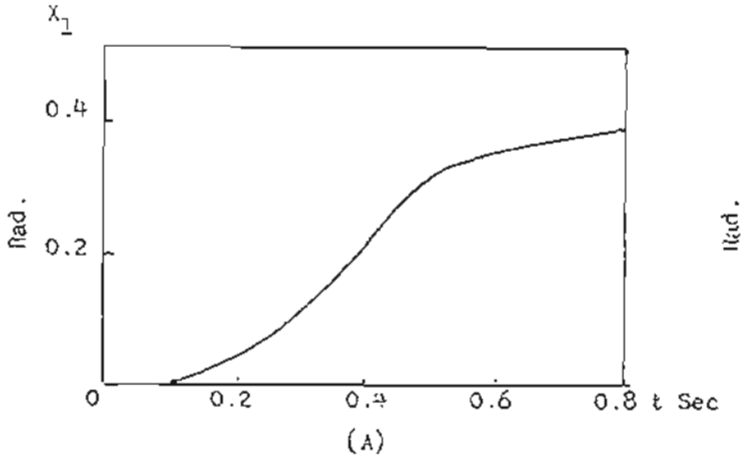
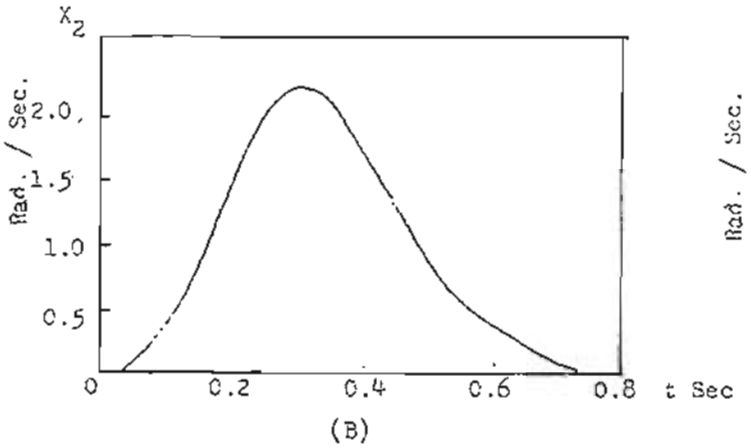


(A)



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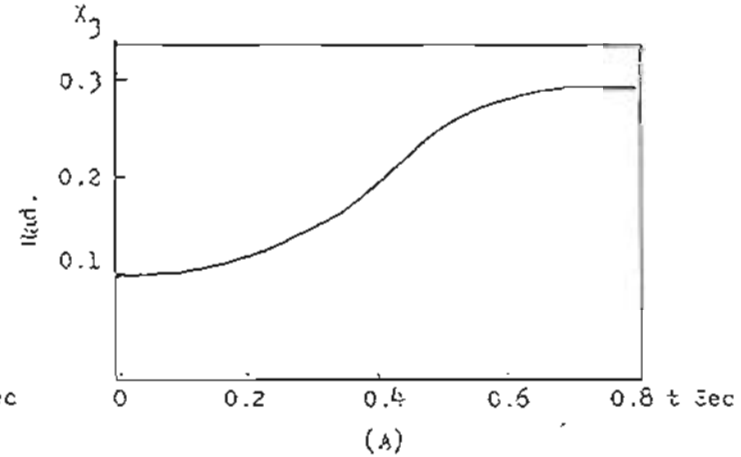
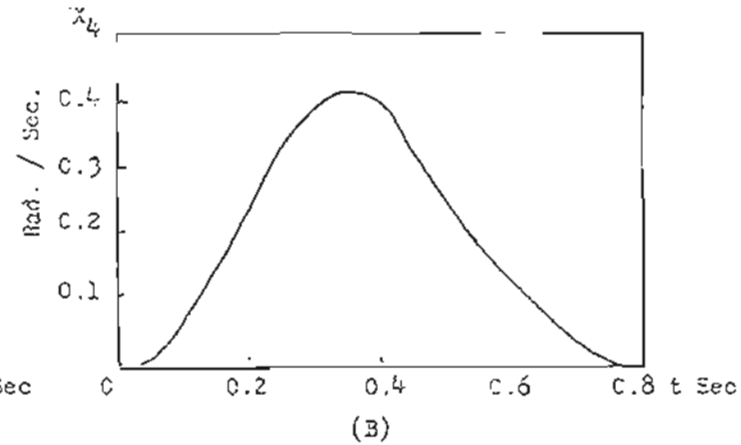
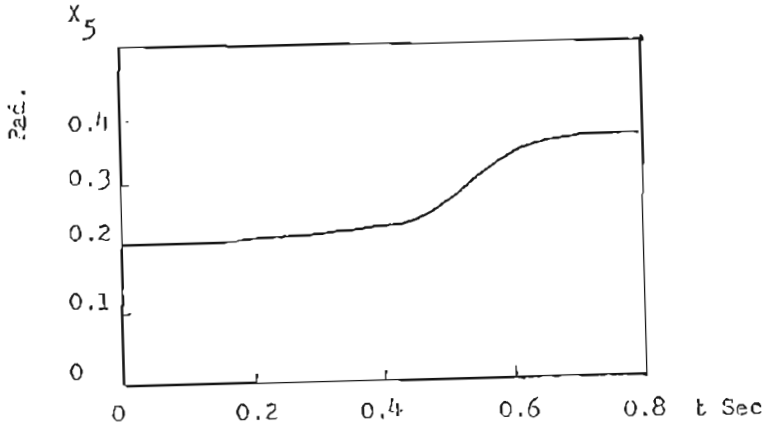


(A)

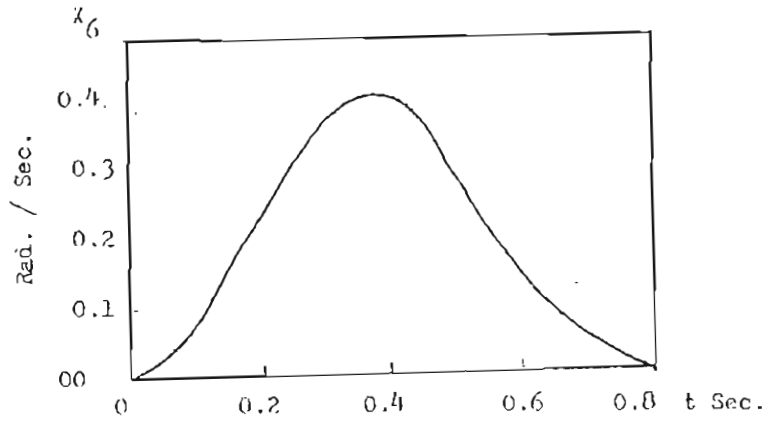


(B)

Figure (6)

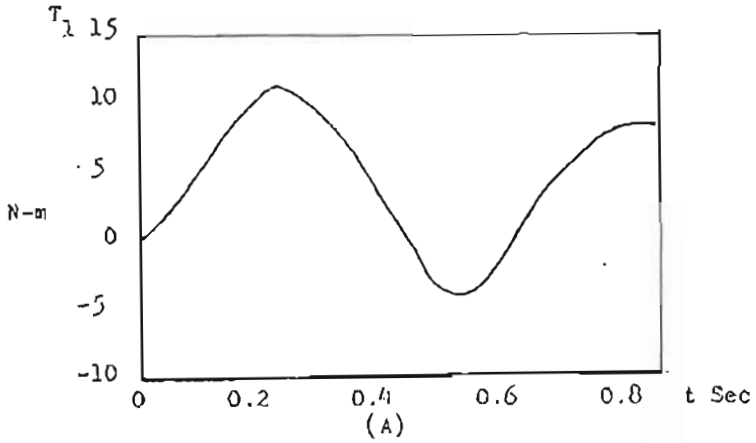

X_5
Rad.
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
t Sec

(A)

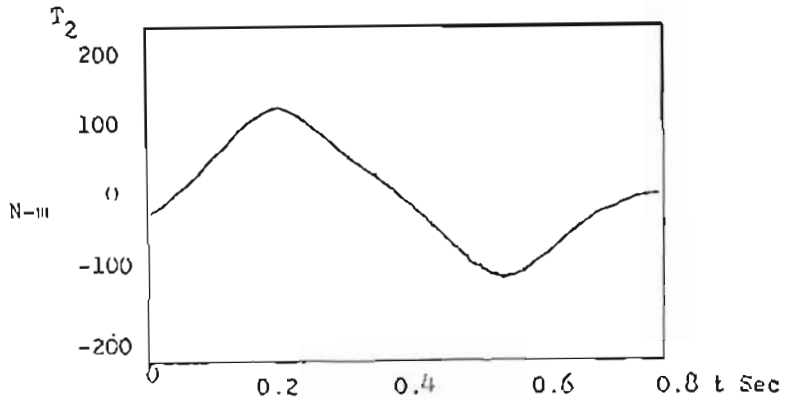

X_6
0.4
0.3
0.2
0.1
00
Rad. / Sec.
0
0.2
0.4
0.6
0.8
t Sec.

(B)

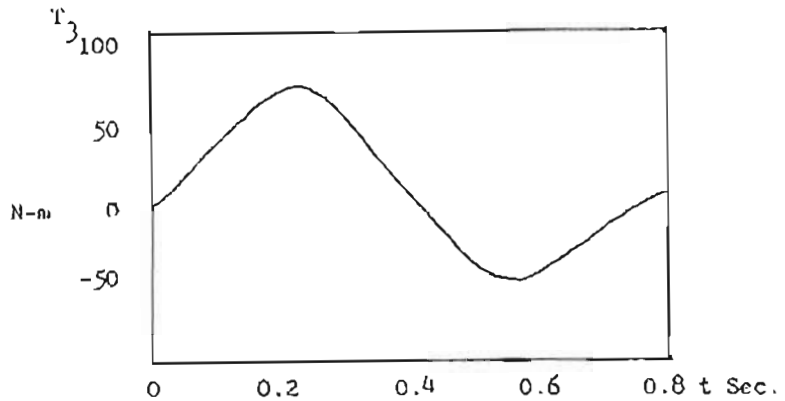
Figure (7)


T_1
15
10
5
0
-5
-10
N-m
0
0.2
0.4
0.6
0.8
t Sec

(A)

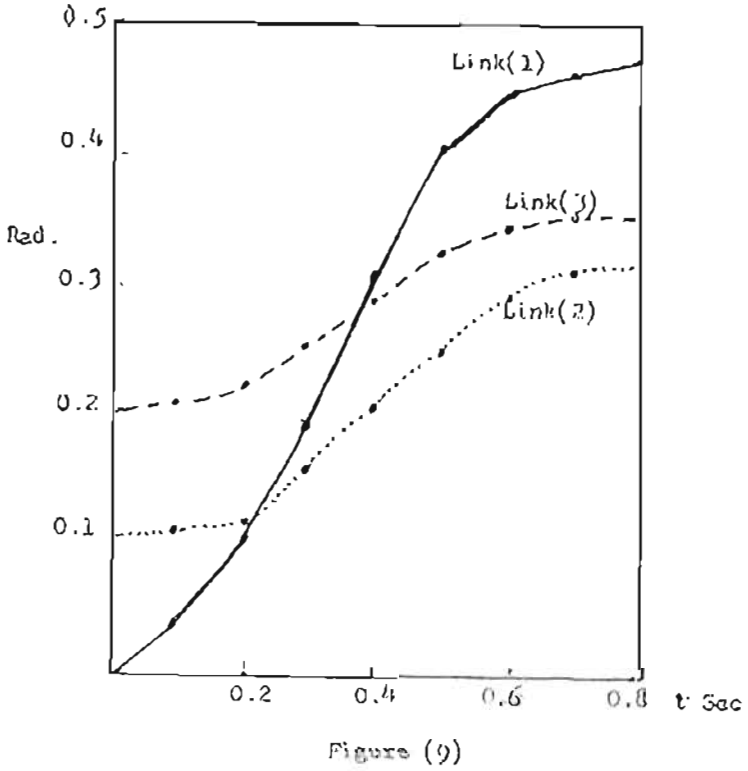

T_2
200
100
0
-100
-200
N-m
0
0.2
0.4
0.6
0.8 t Sec

(B)


T_3
100
50
0
-50
N-m
0
0.2
0.4
0.6
0.8 t Sec.

(C)

Figure (8)



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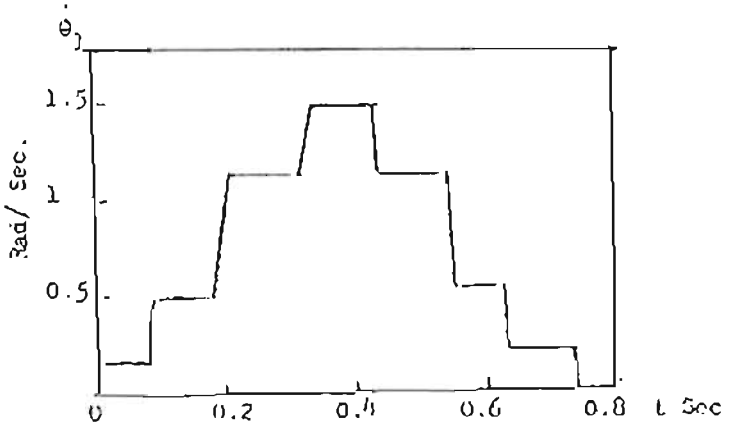
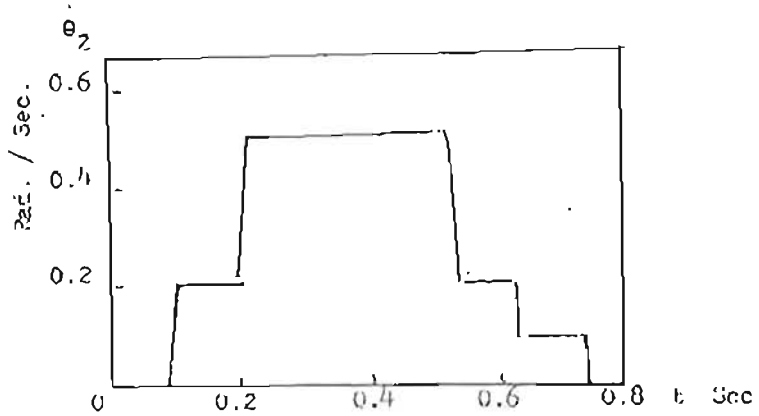


(A)



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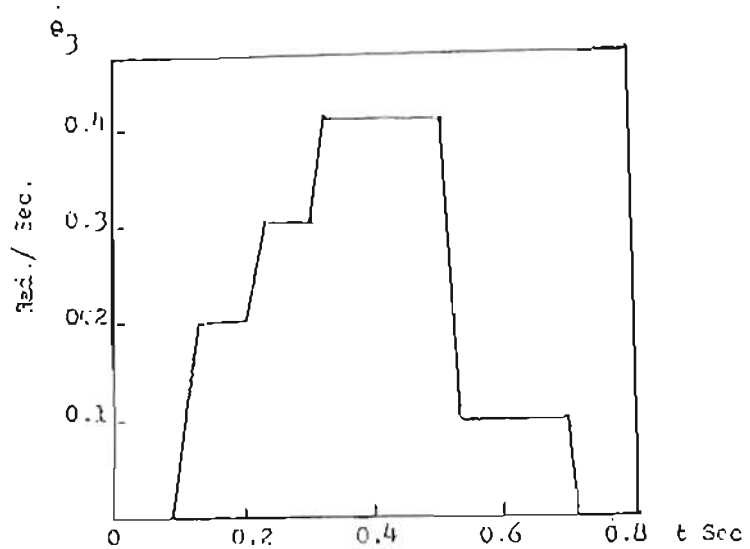

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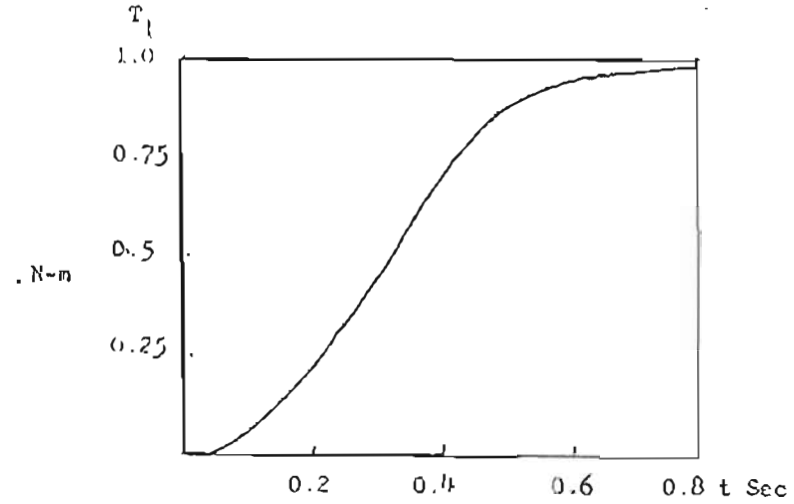
Figure (10)



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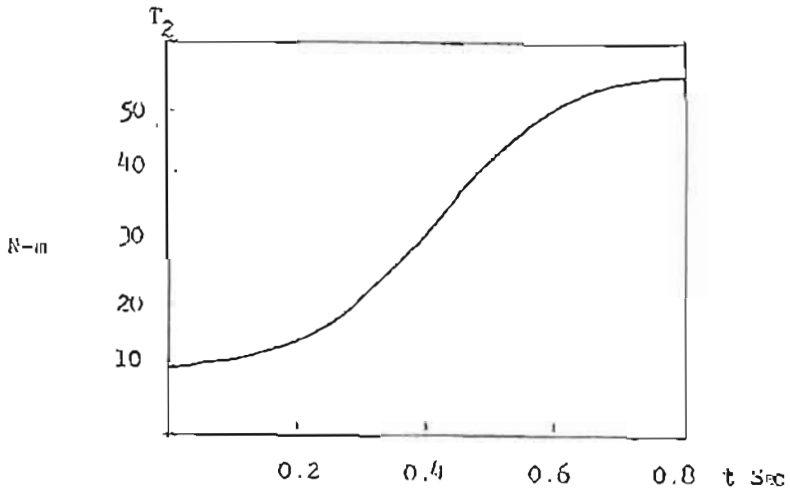

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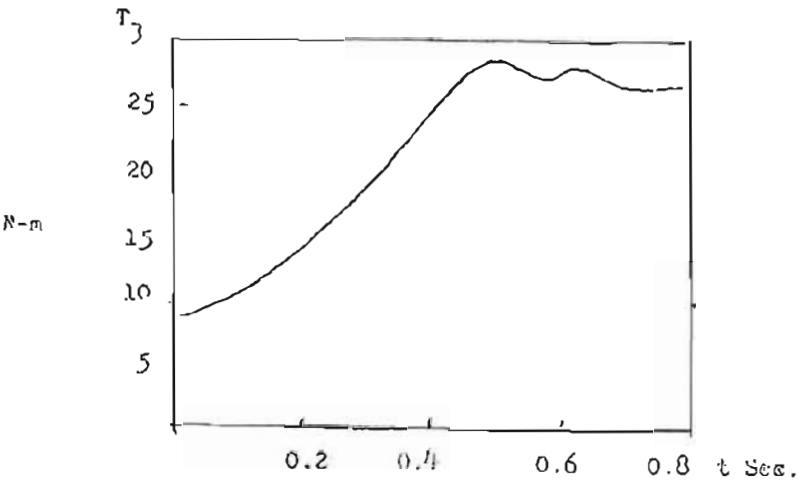

(C)

Figure (11)