Faculty of Physical and Applied Sciences

Electronics and Computer Science

Power Electronics and Drives 2022/23: Assignment

You have received an inquiry from one of your major customers to supply the drive system for an aerospace test system, shown in Figure 1, the purpose of which is to subject the test article to rapid continual motion including acceleration and decelerations. The dimension for the test rig and test article are provided on separate engineering drawing provided. The purpose of this request is to size the system and select suitable components for a ballscrew based drive system for the application.
Due to the application domain a linear motor or belt drive cannot be used.

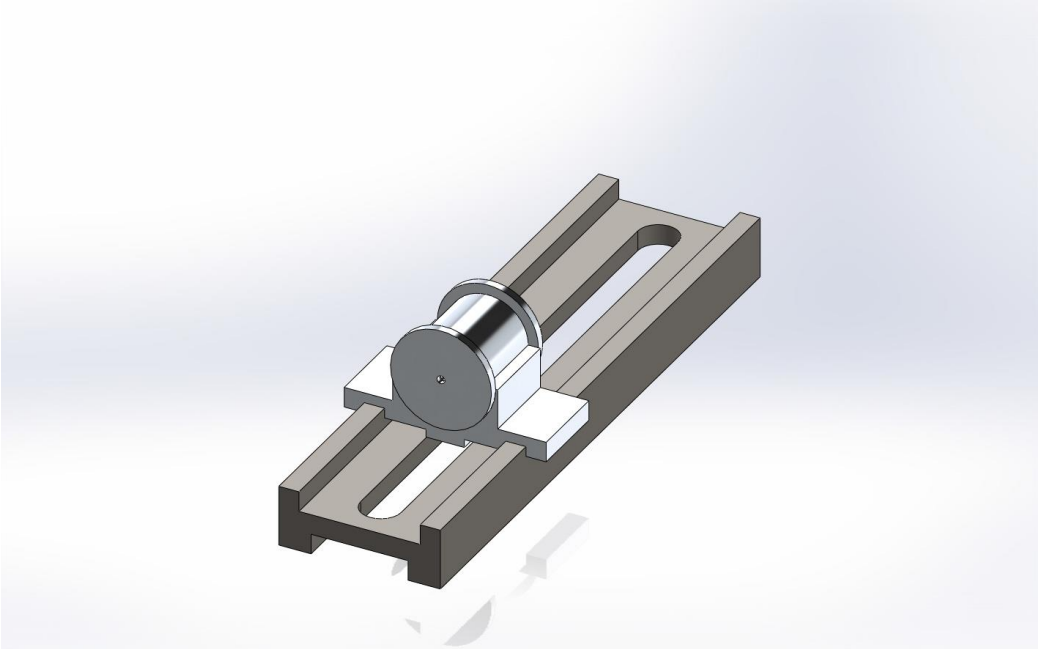

Figure 1: The proposed test system, excluding the motor drive system and associated sensors.

NOTE:
(i) A number of application specific requirements are individually defined and provided on a separate sheet.
(ii) All dimensions on the drawings are in millimetres.

- The test article is filled with one of three liquids, methyl alcohol ((ρ =785 kgm^{-3}), pure water (ρ = 1000 kgm^{-3}) , or 1,2,4-Trichlorobenzene (ρ = 1454kgm^{-3}).

- The system's maximum speed is such that the load can move a predefined distance in a predefined time, the motion profile being a cubic polynomial, as defined on the spreadsheet.

- After completion of a move, the drive reverses. The motion profiles being identical - this motion continues for a considerable period of time.

- No gear box is to be used.

- The carriage structure is manufactured from aluminium (ρ = 2700 kgm^{-3}) and the test article from nylon, (ρ = 1140 kgm^{-3}).

- The friction coefficient (μ) between the carriage and the slideway will not exceed 0.1, due to the provision of a lubrication system.

- A linear positional measurement is required. The required resolution is 10^{-5}m.

- While the system will be used in a laboratory environment, you are not required to consider any environmental requirements.

The ball screw is manufactured from steel (ρ = 7850 kgm^{-3}) and has a radius of 15mm, length of 1.6m and efficiency of 85%. You can assume that the nut and the associated hardware to connect the nut to the carriage has a total mass of 0.5kg.

The motor to be used is to be selected from the following:

Type	Continuous torque (Nm)	Peak torque (Nm)	Maximum Speed (rpm)	Inertia (kgm^2)
AKM11B	0.18	0.61	4000	0.0000017
AKM11C	0.19	0.62	6000	0.0000017
AKM21C	0.48	1.48	2500	0.00001078

You are required to provide the following:

- The completed design summary sheet.

- Detailed design calculations for your selected approach, in your calculations clearly identify any assumptions, and omissions that have been made in your analysis.

- Select suitable components from the supplied list.

- A high quality sketch of the final system. On your drawing identify the key electrical and mechanical components and a suitable location of the limit and datum switches. The drawing can be either drawn by hand or using a drawing/CAD/sketching package. The majority of the marks will come from clarity and annotation. There are no space limitations, below the sideway, in addition no part of the drive system can extend beyond the face marked on the diagram.

You should submit your material on Blackboard in the assignment tab in the usual manner, with a **deadline of 17:00, 27 April 2022**.

Marking Scheme:

Your attention is drawn to the University's Academic Integrity Regulations, and the penalties that can be imposed. The assignment is worth 15% of the module and will be assessed as follows:

- Sizing the application. 70 Marks
- Indicative detailed diagram and components, including provision of limit and datum switches. 30 Marks

University of Southampton
School of Electronics and Computer Science
Application of Modern Drive Systems - 2022/23

Assignment Summary Sheet

You are required to complete this summary sheet and include it as part of your submission, **the answers are required in the units shown**.

Name

Student ID

MOTION PROFILE

Distance moved by load

mm

Time per move

s

P*eak load speed*

ms^{-1}

Peak load acceleration

ms^{-2}

LOAD

Total load mass: carriage, nut and filled test article

kg

FRICTION FORCES

Friction

N

BALL SCREW

Ball screw inertia excluding nut

kgm^2

Peak rotational speed

Rpm

Peak rotational acceleration

$rad\ s^{-2}$

Reflected inertia of the load

kgm^2

Total system inertia

kgm^2

Peak acceleration torque required into ball screw

Nm

Motor Selection

Motor part number

Motor peak torque

Nm

Continuous torque rating

Nm

Motor inertia

kgm^2

Peak Motor Speed

Rpm

Verification

Total SYSTEM Inertia

kgm^2

Required Peak Torque

Nm

R.M.S Torque Required

Nm

Is motor Usable

Yes/No

Student Name		ID/email	T (sec)	Distance (mm)	Liquid	Lead(mm)
Sandaru	Algoda Gamaethiralalage	sdag1n21@soton.ac.uk	6	800	Water	25
Don	Amarasekara	ddha1c20@soton.ac.uk	8	750	Methyl alcohol	10
Aimilios	Angelopoulos	aa3u21@soton.ac.uk	6	500	Trichlorobenzene	15
Laura-Jane	Apthorp	lja2g21@soton.ac.uk	8	600	Water	20
Robert	Aries	raa1g21@soton.ac.uk	9	450	Water	25
Samarth	Basavapatna	ssb1g21@soton.ac.uk	9	800	Methyl alcohol	25
Lisa	Bidgood	lb11g21@soton.ac.uk	5	750	Trichlorobenzene	10
Luca	Bowe	lwrb1g21@soton.ac.uk	4	500	Water	15
Kaya	Boyacioglu	mkb1g21@soton.ac.uk	4	600	Water	20
Cecil-Maurice	Browne	cmb1g20@soton.ac.uk	5	450	Methyl alcohol	25
Huw	Burgin	hb3g21@soton.ac.uk	8	800	Trichlorobenzene	25
Hongjun	Cai	hc1g21@soton.ac.uk	6	750	Water	10
Chun	Cho	cc10g21@soton.ac.uk	8	500	Water	15
Ching	Chu	chic1g21@soton.ac.uk	9	600	Methyl alcohol	20
Patrick	Clout	pc1g21@soton.ac.uk	4	450	Trichlorobenzene	25
Maxwell	Cox	mjc1g21@soton.ac.uk	5	800	Water	25
Oliver	Enrico	ojme1n21@soton.ac.uk	4	750	Trichlorobenzene	10
Rekem	Ereku	rtge1g21@soton.ac.uk	4	500	Water	15
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Kharrum	Hudson	kh5g21@soton.ac.uk	9	450	Trichlorobenzene	10
William	Jameson	wj3g21@soton.ac.uk	8	800	Water	15
Samuel	Jasper	sj3g21@soton.ac.uk	5	800	Methyl alcohol	20
Abi	Johnson-Brett	aljb1g21@soton.ac.uk	4	750	Trichlorobenzene	25
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Isa	Khalil	mik1u21@soton.ac.uk	9	750	Methyl alcohol	10
Ibrahim	Khan	ik4g21@soton.ac.uk	9	500	Trichlorobenzene	15
Jawadur	Khan	jrk1e21@soton.ac.uk	5	600	Water	25
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Stepan	Kononko	sk3g21@soton.ac.uk	4	800	Methyl alcohol	25
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Cameron	Philip	cmp2g20@soton.ac.uk	9	450	Methyl alcohol	20
Xiuping	Qi	xq3g21@soton.ac.uk	5	800	Trichlorobenzene	25
Humzah	Rathur	hr7g21@soton.ac.uk	4	750	Water	25
Quinn	Rice	qr1g21@soton.ac.uk	4	500	Water	10
Peter	Richards	prr1g21@soton.ac.uk	5	600	Methyl alcohol	15
Seb	Rigg	sr10g21@soton.ac.uk	8	450	Trichlorobenzene	20
Nikita	Rolls	nr3g21@soton.ac.uk	6	500	Water	25
Zhangqian	Rui	zr1g21@soton.ac.uk	8	600	Water	25
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Bartosz	Sarwa	bs7g21@soton.ac.uk	5	600	Trichlorobenzene	25
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Eszter	Szabo	ers1u21@soton.ac.uk	8	750	Water	20
Jun	Tan	jt10g21@soton.ac.uk	9	500	Methyl alcohol	25
Wai	Tang	wwt1u21@soton.ac.uk	4	600	Trichlorobenzene	25
Shehroz	Tariq	st1e20@soton.ac.uk	5	800	Water	10
Ahpiraam	Thussanthan	at18g21@soton.ac.uk	4	750	Water	15
Jade	Vaux	jv1g21@soton.ac.uk	8	500	Trichlorobenzene	20
Denel	Virendrakumar	dv2g21@soton.ac.uk	5	600	Water	25
Gagan	Vithanala	gv4g21@soton.ac.uk	8	450	Methyl alcohol	25
Gia	Vu	gnv1g21@soton.ac.uk	6	800	Trichlorobenzene	10
Xucheng	Wang	xw6n20@soton.ac.uk	8	750	Water	15

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Yat	Wong	yw15g21@soton.ac.uk	5	800	Trichlorobenzene	10
Yufei	Xi	yx3g21@soton.ac.uk	4	750	Water	10
Siqi	Xu	sx5n21@soton.ac.uk	8	500	Water	15
Sasank	Yadavalli	hsy1g21@soton.ac.uk	9	600	Methyl alcohol	20
Jiakun	Yang	jy2u20@soton.ac.uk	9	450	Trichlorobenzene	25
Xiaoqing	Yang	xy5g21@soton.ac.uk	5	800	Water	25
Muhammad	Yusri	mhby1g21@soton.ac.uk	4	800	Methyl alcohol	10
Syazwan	Zulkepli	ssdz1g21@soton.ac.uk	4	750	Trichlorobenzene	15