

DEPARTMENT OF AEROSPACE ENGINEERING
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Helicopter Theory

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1. An experiment on a model helicopter was performed to measure the variation of rotor loads due to a step increase in engine throttle. The helicopter was mounted (clamped) on a 6-component load cell. Tail rotor is not connected, hence there is no power given to the tail rotor.

Relevant data pertaining to the model helicopter are given in the following.

Weight of the helicopter: 80 N (Not relevant)

Density of air: ρ	1.225 kg/m ³
Number of blades: N	2
Blade radius: R	0.8 m
Blade chord: C	0.06 m
Profile drag coefficient: C_{d0}	0.01
Lift curve slope: a	5.73
Tip loss factor: B	0.97
Root cut-out:	0.15R
Mass of blade: M	0.197 kg (assume uniform blade)

Blade twist: $\theta_{tw} = 0$ deg,

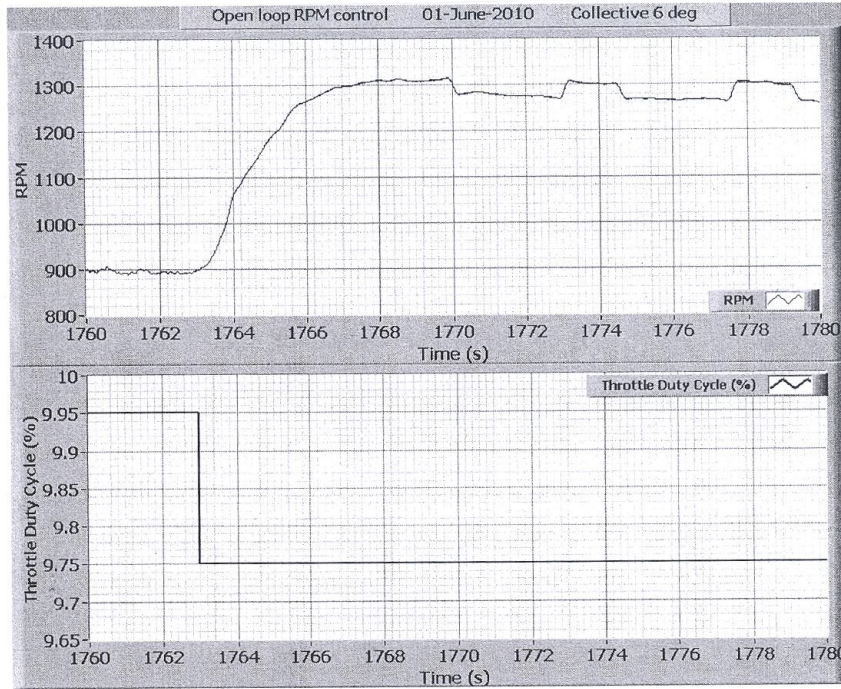
Note: The rotor is operating under hovering condition. The measured experimental data is provided in the attached sheet.

The rotor is initially operating at 900RPM and collective pitch angle is set at 6 deg.. Cyclic pitch is zero. Engine throttle is increased by a step input as shown in Fig. b (Note: A reduction in duty cycle increases the engine power). The time response of rotor RPM, rotor thrust (F_z) and rotor torque (M_z) are continuously monitored and they are shown in Figs. a, c and d, respectively.

Make your assumptions and state them explicitly in the beginning of your assignment sheet.

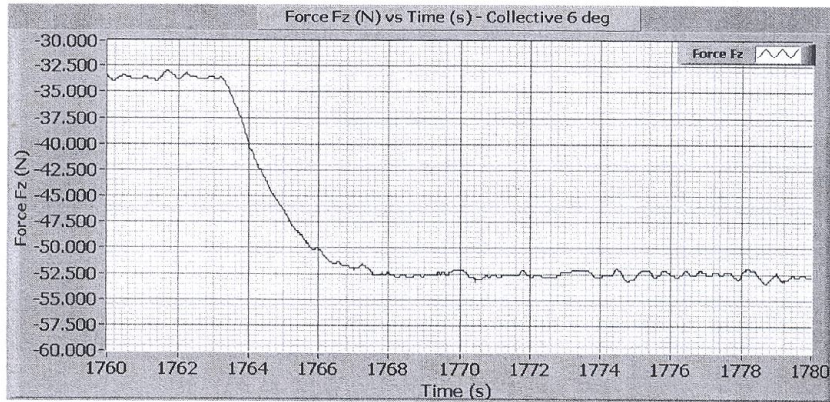
- (1) Using the data, evaluate the initial and final thrust, torque and power supplied by the engine to the rotor. Compare the theoretical and experimental data for the change in thrust and torque due to increase in engine power. What could be the reasons for the observed difference?
- (2) Derive a simulation model for the time variation in rotor rpm, thrust and torque due to step change in engine power.
- (3) What is reason for the observed peak (dip) in the rotor torque?

Open Loop Test – Collective 6 deg

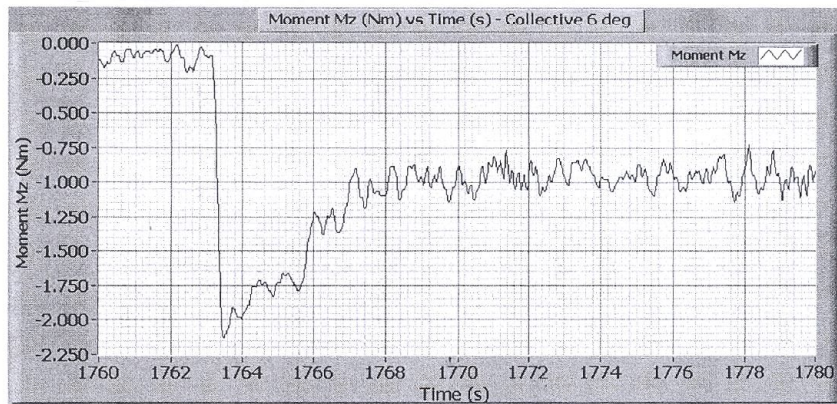


(a)

(b)



(c)



(d)