Problem T1. Stabilizing unstable states *(11 points)*

Part A. Stabilization via feedback *(3.5 points)*

i. (1.5 pts)

$\ddot{\varphi} =$

Proof that $\varphi(t) = A\mathrm{e}^{t/\tau} + B\mathrm{e}^{-t/\tau}$

$\tau =$

ii. (0.5 pts) Inequality for the rod length (symbolically and value in meters):

iii. (0.5 pts) Upper bound for the bird reaction time (symbolically and value in seconds):

$\tau_{rb} <$

iv. (1 pt) Minimal driving speed (symbolically and value in meters per second):

$v_b =$

Part B. Tightrope walker *(3.5 points)*

i. (1 pt)

$\alpha_1 =$

$\alpha_2 =$

ii. (0.5 pts) State wether $\beta_0 > 0$ or $\beta_0 < 0$:

Motivation:

iii. (1 pt)

$\dot{\alpha}_1/\alpha_1 =$

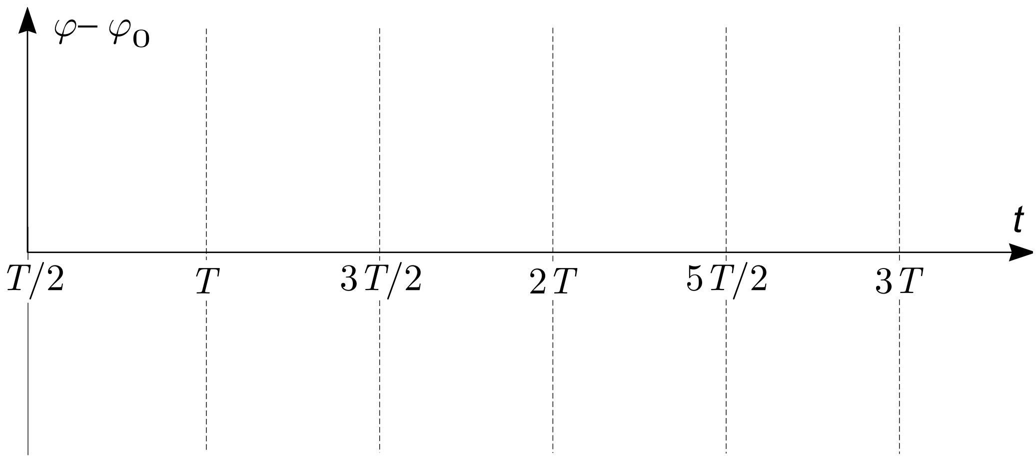
iv. (1 pt)

$T_b =$

Part C. Kapitza's pendulum *(4 points)*

i. (1.5 pts)

Sketch here the graph:



$\Delta\varphi = \varphi(T) - \varphi(T/2) =$

ii. (1.5 pts) Average torque:

$\langle M \rangle =$

iii. (1 pt) Kapitza's pendulum is stable if (state the inequality):

Problem T2. Gravitational waves *(10 points)*

Part A. Dipole radiation *(2.4 points)*

i. (1.4 pts)

$P =$

$\lambda =$

ii. (1 pt) Proof that $P_{gd} = 0$:

Part B. Quadrupole radiation *(7.6 points)*

i. (1 pt)

$\omega =$

ii. (0.8 pts)

$P_{qg} =$

iii. (0.8 pts)

$S = Kh_0^2$, where $K =$

iv. (1 pt)

$h_0 =$

v. (1 pt)

$R_s =$

vi. (1.5 pts)

$M =$

vii. (1.5 pts)

$L =$

Problem T3. Magnetars *(9 points)*

i. (1.5 pts)

$B_0 =$

ii. (1 pt)

$B(t) =$

iii. (1 pt)

$\omega_n =$

iv. (1.5 pts)

$B(t) =$

v. (1 pt)

$B_{\max}$

vi. (1 pt)

$B_H =$

vii. (2 pts)

$\kappa =$