

Ph 205 2ND MID TERM EXAM

DUE IN CLASS TUESDAY DEC. 7, 1982

THIS IS A TAKE HOME EXAM

TIME LIMIT = 90 MINUTES IN ONE CONTINUOUS SITTING

THE EXAM IS CLOSED BOOK, CLOSED NOTES, ETC.

THE EXAM CONSISTS OF 3 PROBLEMS WORTH 10 POINTS EACH. THE EXAM COVERS THE MATERIAL OF LECTURES 9 THRU 18 INCLUSIVE.

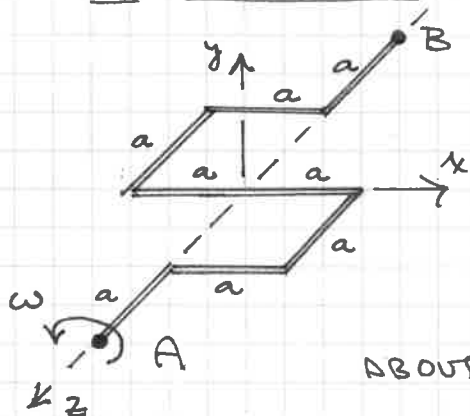
PLEASE DO ALL WORK YOU WISH GRADED IN THE EXAM BOOKLETS PROVIDED.

① CLASSICAL NUCLEAR FORCES. THE FORCE WHICH HOLDS PROTONS AND NEUTRONS TOGETHER IN THE NUCLEUS IS "SHORT RANGE" - IT DIES AWAY QUICKER THAN $1/r^2$. A SIMPLE MODEL IS TO SUPPOSE THE FORCE IS CENTRAL, WITH DEPENDENCE

$$\vec{F} = -\frac{\alpha}{r^2} e^{-\beta r} \hat{r}$$

FIND A CONDITION FOR STABILITY OF CIRCULAR ORBITS FOR A PARTICLE MOVING ABOUT A FIXED FORCE CENTER UNDER THIS FORCE. EXPRESS THE FREQUENCY OF SMALL OSCILLATIONS ABOUT A CIRCULAR ORBIT IN TERMS OF THE ROTATION FREQUENCY OF THE EQUILIBRIUM ORBIT.

② THE CRANKSHAFT



AN AUTOMOBILE CRANKSHAFT IS A PLANAR RIGID BODY MADE OF 8 RODS EACH OF MASS M , LENGTH a WELDED TOGETHER AS SHOWN.

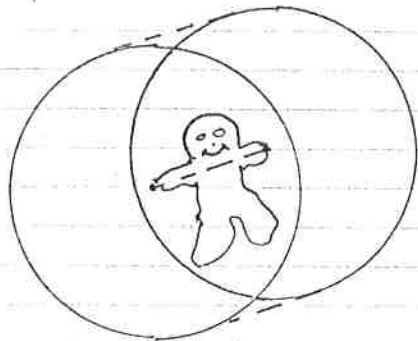
SUPPOSE THE CRANKSHAFT ROTATES ABOUT THE z AXIS WITH CONSTANT ANGULAR VELOCITY ω . FIND THE DIRECTIONS AND MAGNITUDES OF THE FORCES ON THE TWO BEARINGS A AND B AT A MOMENT WHEN THE CRANKSHAFT LIES IN THE $x-z$ PLANE AS SHOWN. THE BEARINGS ARE LOCATED ON THE ENDS OF THE TWO RODS WHICH LIE ALONG THE x AXIS.

IGNORE GRAVITY.

NOT FOR CREDIT: YOU MAY WISH TO CONSIDER HOW YOUR ANSWER WOULD DIFFER IF ω WAS NOT CONSTANT.

③ TOYS 'A' WHO? A TOY CONSISTS OF TWO HOOPS

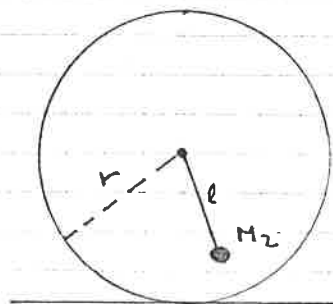
WITH A COMMON AXIS JOINED TO FORM A KIND OF WHEEL. A TEDDY BEAR IS SUSPENDED FROM THE AXLE OF THE WHEEL AND IS FREE TO ROTATE ABOUT THE AXLE.



DESCRIBE THE NORMAL MODES OF THIS DEVICE. GIVE BOTH THE FREQUENCIES AND THE RATIOS OF THE AMPLITUDES OF THE MOTION OF RELEVANT VARIABLES.

FOR PURPOSES OF ANALYSIS IT IS SUFFICIENT TO CONSIDER A SIMPLER SYSTEM. A SINGLE HOOP HAS RADIUS r AND MASS M_1 . SUSPENDED FROM THE C.M. IS A MASS M_2 ON A MASSLESS ROD OF LENGTH l .

THE ROD IS FREE TO ROTATE ABOUT THE HOOP'S C.M.



THE "EQUIVALENT TOY"

↓ GRAVITY

THE HOOP ROLLS WITHOUT SLIPPING ON A HORIZONTAL PLANE.

ALL MOTION TAKES PLACE IN A VERTICAL PLANE.