國 立 清 華 大 學 命 題 紙

九十一學年度 微機電系統工程 系（所） 組碩士班研究生招生考試

科目 普通物理 科號 2203 共 4 頁第 1 頁 *請在試卷【答案卷】內作答

1. As shown in Fig. 1, the motion of a simple pendulum is periodic and oscillatory. Assume the angular displacement θ is small, determine the oscillation frequency of the pendulum when (a) the block is fixed, and (b) when the block is moving with a constant acceleration A in the positive y direction, (10%)

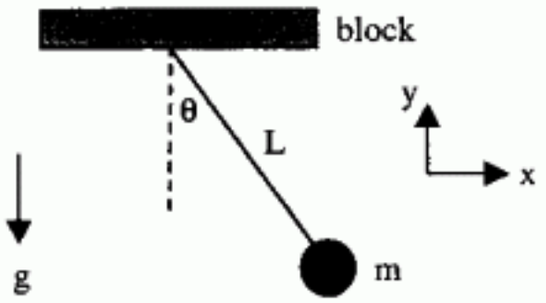


Fig. 1

2. A mass m on a frictionless table is attached to a hanging mass M by a cord through a hole in the table, as shown in Fig. 2. The mass m is under a circular motion with radius r, and the magnitude of v is constant. Find the relation between v and r so as to allow M to stay at rest (5%)

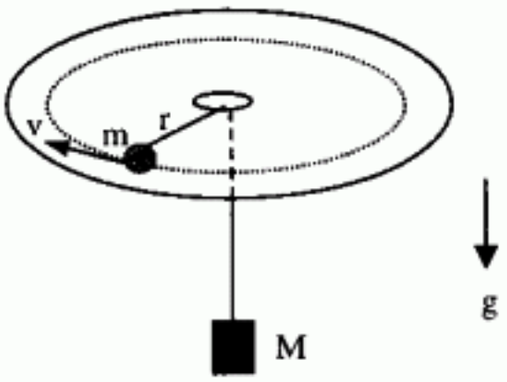


Fig. 2

3. The uniform plank AB shown in Fig. 3 has a mass of 15 kg and rests against a floor and wall for which the coefficients of static friction are $\mu_{floor} = 0.3$ and $\mu_{wall} = 0.2$, respectively. Determine the distance s to which a man having a mass of 70 kg can climb without causing the plank to slip. (10%)

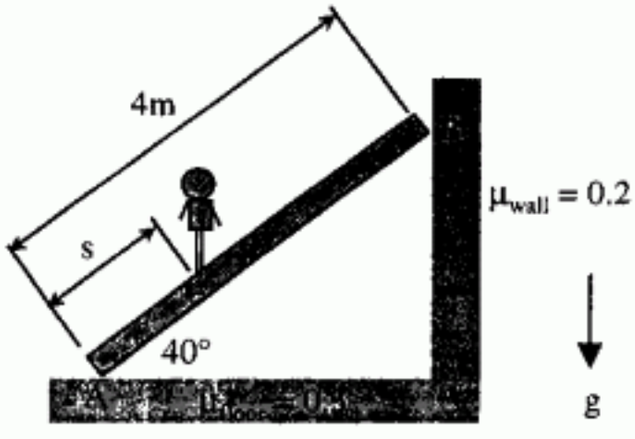
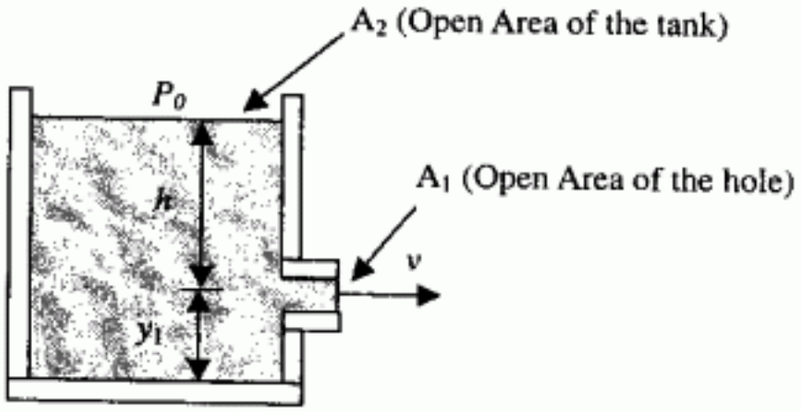


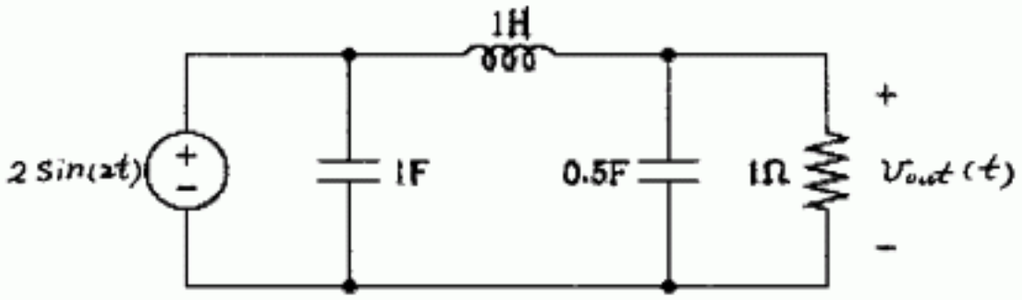
Fig. 3

4. Please explain the three laws of thermodynamics: the zero law, the first law and the second law. (10 %)

5. A tank containing a liquid of density ρ has a hole in its side at a distance y_1 from the bottom (see figure). The diameter of the hole is small compared to the diameter of the tank. The air above the liquid is maintained at a pressure P_0. Determine the speed v at which the fluid leaves the hole when the liquid level is distance h above the hole. (15 %)



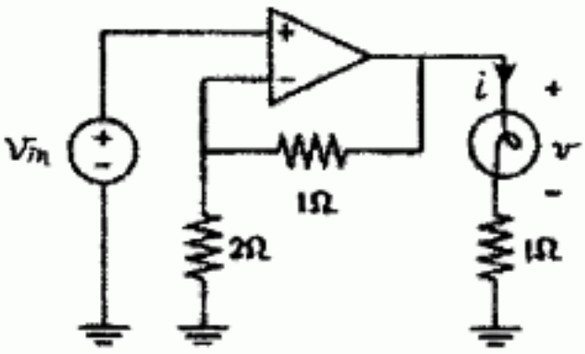
6. The circuit below is operating in sinusoidal steady-state. Find $v_{out}(t)$, expressed in the form $v_{out}(t)=\alpha\cos(\omega t+\phi)$, with ϕ in radians. (8%)

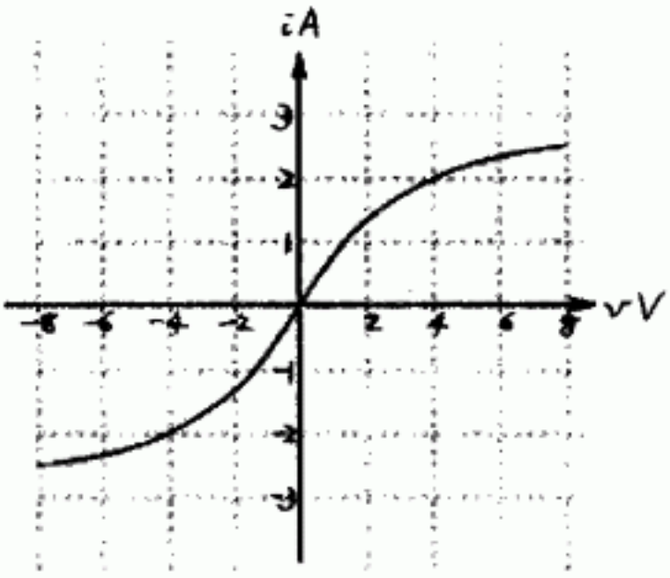


7. Consider the circuit in the following figure. The voltage drop cross the light bulk is v. The current through the light bulk is *i*. The v_{in} is voltage supplied. We wish to operate the light bulb with the given v-*i* characteristics at power p=8W (the power consumption on the light bulb).

   (a) Assume the idea op-amp model, find v_{in}. (5%)

   (b) Find the power supplied or dissipated by the op-amp (output). (4%)





8. The earth's magnetic field is about 0.5 Gauss. If a loop of wire with a radius of 10 cm is rotated at 10 RPM (Round per Minute) on an axis perpendicular to the earth's field, what voltage would appear across the ends of the loop? (Hint: 1 Gauss=10^{-4} Tesla) (8%)

9. A 45°-90°-45° prism used in air (see Figure 9)

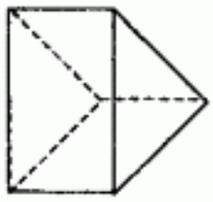


Figure 9

(a) What is the minimum reflection index of this prism in order to get "total internal reflection?" (4%)

(b) Sketch two different optical paths of "total internal reflection" of this prism. (4%)

(c) Please use two identical 45°-90°-45° prisms to design an optical system so that the incident light path is parallel to the reflected light path. In this optical system, "total internal reflection" is the only optical law allowed. (5%)

10. Examine a simplified model of the Grating-Light-Valve (GLV) device (see Figure 10). GLV uses diffraction to control pixel intensity in a projected image (on screen).

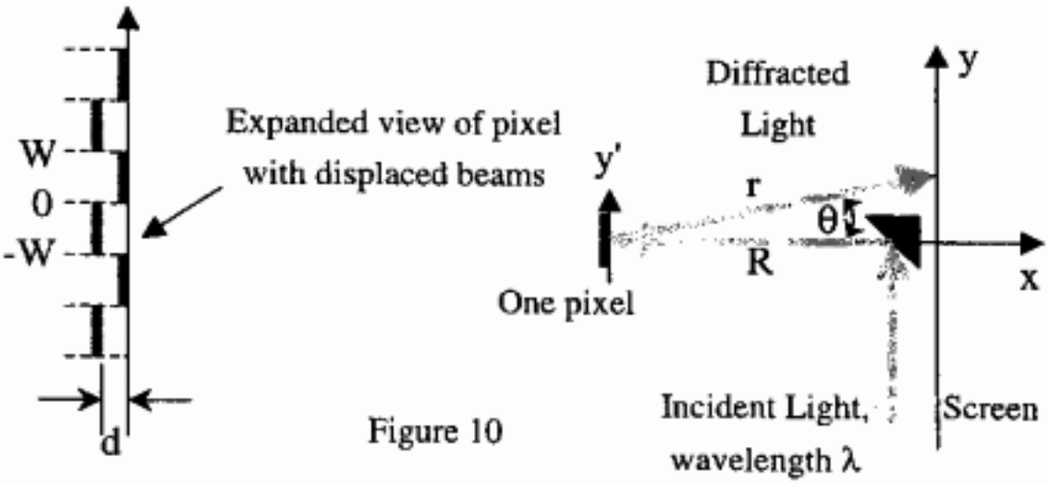


Figure 10

(a) The optical wave amplitude can be approximated as

$$\Psi(R,y) \propto \exp^{ikr_0}\left[1+2\cos(2kW\sin\theta)\right] \times\left[e^{ikW(\sin\theta)/2}e^{ikd(1+\cos\theta)}+e^{-ikW(\sin\theta)/2}\right]\times\frac{\sin(kW(\sin\theta)/2)}{(kW(\sin\theta)/2)}$$

At what angle the peak diffraction intensity occurs? (3%)

Please describe which part of the above equation is the famous Fraunhofer diffraction result from a single slit of width W. (3%)

(b) Each alternative pixel can move by a distance d. By what kind of displacement do the alternative pixels move so that the intensity of the diffracted signal reaches minimum and maximum? Use $k = 2\pi/\lambda$. (6%)