1. (a) How do the emitting colors of semi-conducting materials change by 
p-doping and n-doping, and how do their HOMO (highest occupied 
molecular orbital in valence band) and LUMO (lowest unoccupied molecular 
orbital in conduction band) energy levels change by p-doping and n-doping.
(b) Explain why the thin films of semi-conducting materials become more 
transparent as the conductivity is reduced.
(c) Compare the differences of chemical structural requirements and process 
conditions in semi-conducting organic (hydrocarbon-related) materials and 
semi-conducting inorganic (Si-related) materials.

2. (a) What are the definitions of refractive index and dielectric constant.
(b) Explain the principle to measure the refractive index and dielectric 
constant, and the parameters to influence these values in liquid crystals.
(c) Explain why liquid crystals can be used in displays regarding their 
refractive and dielectric properties.

3. Describe the techniques to determine if a thin film transistor is amorphous 
Si or polycrystalline Si type, and show the reasons why they can do it.

4. To characterize a transparent conducting electrode of indium tin oxide for 
flat panel displays, list a number of possible ways for the measurement of 
surface roughness and chemical compositions with the related basic 
principles.

5. (製程檢測技術) LCD 彩色濾光片的製程為主要是先在玻璃基板上蒸鍍一層 
金屬鈦或金屬鋁與氧化鈦的複合蒸鍍，再以光阻微影蝕刻的製程製作出格子 
狀的黑色矩陣(Black Matrix)。其後交次以紅、綠、藍光阻將彩色濾光層製 
作在基板上，接著全面塗佈一層平坦層，再蒸鍍一層透明導電電極於其上。 
再以光阻製作間隙物( photo spacer)於所完成的彩色濾光片上，用來控制 LC 
Cell 的間距。在各製程中需針對表面形狀、異物、膜厚、色度、光學密度等 
參數作製程監控。針對彩色濾光片製程量測參數，請說明下列量測參數的定 
義: (a) 黑色矩陣(Black Matrix)之光學密度; (b) RGB 之色度; (c) Photo 
Spacer 之膜厚.
6. An inverted pendulum shown in the following Figure has the transfer function

\[ G_p(s) = \frac{\Theta(s)}{T(s)} = \frac{2}{s^2 - 2} \]

Where \( \Theta(s) \) represents the angle of the rod and \( T(s) \) represents the torque applied by a motor at the base.

(a) Sketch the root locus for a proportional controller, \( G_c(s) = K_p \). What type of closed-loop response would you expect for different values of \( K_p \)?

(b) Design a lead controller of the form

\[ G_c(s) = K_L \frac{s - Z_c}{s - P_c} \]

Choose \( Z_c = -3 \), and solve for \( P_c \) from the angle criterion so that the dominant closed-loop poles are at \(-3 \pm 3j\).

Draw the resulting root locus for this system, and calculate the gain \( K_L \) that results in the desired closed-loop poles.

7. To create the voltages of 1.3 V, 2.8 V, and 3.6 V using a DC voltage source of 5 V and 5 resistors.

(a) Draw the circuit of your design.

(b) What is the power consumption of your design?
8. For the input voltage $V_{in}$ and the RC circuit shown below, $V_{in}$ changes from 30 V to -2 V at the moment when time $t = 0$ sec.
   (a) Draw the waveform of $V_x$.
   (b) Describe how to calculate the moment when $V_x = 5$ V.

9. (a) Please write the 4-terms of differential and integral form of Maxwell’s equation (with time-varying).
   (b) Explain the physical meaning of each term of the Maxwell’s equation.

<table>
<thead>
<tr>
<th>Differential Form</th>
<th>Integral Form</th>
<th>Physical meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nabla \times E =$</td>
<td>$\int_{\Lambda} E \cdot d\lambda =$</td>
<td></td>
</tr>
<tr>
<td>$\nabla \times H =$</td>
<td>$\int_{\Lambda} H \cdot d\lambda =$</td>
<td></td>
</tr>
<tr>
<td>$\nabla \cdot D =$</td>
<td>$\int_{S} D \cdot ds =$</td>
<td></td>
</tr>
<tr>
<td>$\nabla \cdot B =$</td>
<td>$\int_{C} B \cdot ds =$</td>
<td></td>
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</tbody>
</table>

10. Please explain what is “Electrostatic shielding (靜電屏蔽效應)”, and give an application example of the effect.