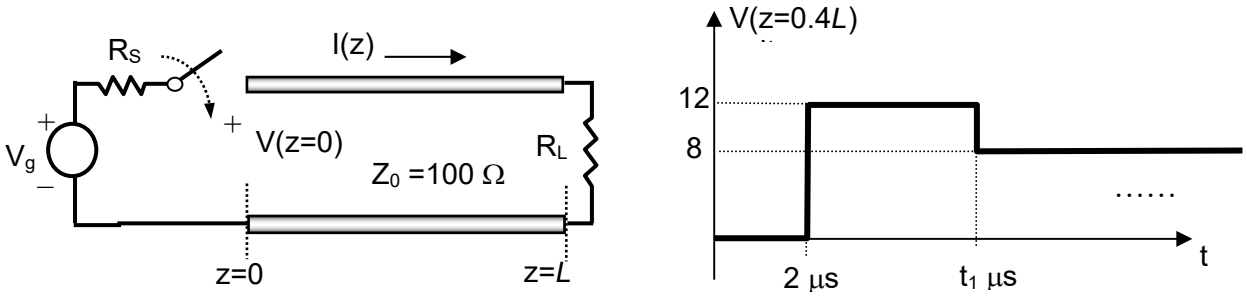
Electromagnetic Wave
The Final Examination
6/7/2021 (Monday) 8:00 AM-12:00 PM

4 大題 ，總分 103 分 (+ 8 分 Bonus)

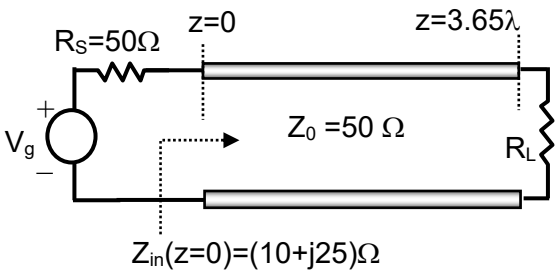
(37%) **1.** A 100-Ω TEM dielectric-filled (ε_r=9) transmission line is excited by connecting it to the voltage source at t = 0 shown as below. The voltage V(z = 0.4L, t) observed at the input of the line is given by :



(a) (3%) What is the propagation velocity v_p of this transmission line ?
(b) (3%) What is the length *L* of this line?
(c) (3%) Find t_1 where the voltage is changed.
(d) (3%) What is the reflection coefficient Γ_L?
(e) (3%) What is the value of the load R_L?
(f) (3%) What is the value of the load R_S?
(g) (3%) What is the value of generator voltage V_g?
(h) (6%) Draw the equivalent lump circuit model of this transmission line; find the value of the capacitance $C\ell$ and inductance $L\ell$ per meter ?
(i) (5%) Plot the bounce (Reflection) diagram (Time vs. z)
(j) (5%) Plot voltage vs. time observed at z = 0.8L (t =0 ~ 12 μs)

(18%) **2.** A 50-Ω transmission (3.65λ-long) is connected to a voltage generator that has an impedance of 50 Ω. It's known that input impedance at z=0 (at generator) is (10+j25) Ω.

(a) (3%) What is the voltage standing wave ratio on this line?
(b) (3%) What is the load impedance R_L?
(c) (3%) What is the reflection coefficient at the load ? ($|\Gamma|e^{j\theta}$)
(d) (3%) How far is the first voltage minimum from the load ?
(e) (3%) How far is the first voltage maximum from the load ?
(f) (3%) What is the input impedance at the position z=1.5 λ ?



(18%) **3.** The 50-Ω transmission line is required to deliver equal power to two separated loads (Z_{L1}, Z_{L2}) which are connected in parallel. To accomplish this mission, only quarter-wavelength (λ/4) transformer can be used for impedance matching line. Assume that all lines are lossless, please answer the following questions:

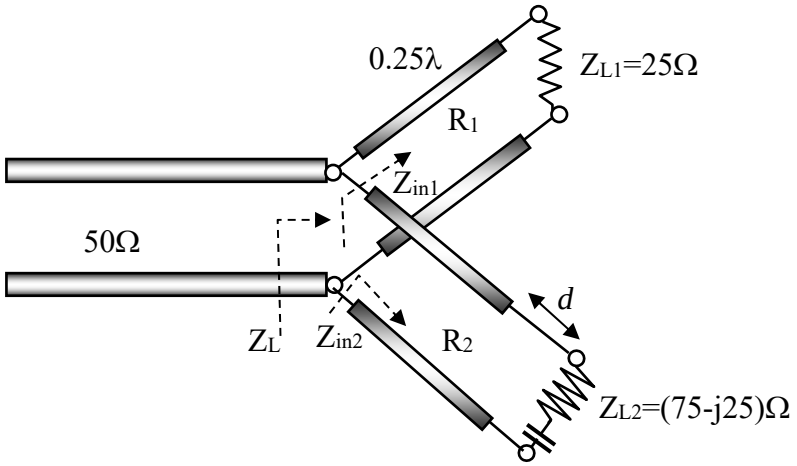
(a) (3%) Find Z_L for 100% power delivering.

(b) (6%) Find Z_{in1} and Z_{in2} for equal power splitting

(c) (3%) For Z_{L1}, find the impedance R_1 of the inserted λ/4 transformer.

(d) (3%) Since Z_{L2} is NOT a pure resistance, find the minimum distance *d* that λ/4 transformer can be used for matching.

(e) (3%) Continue with (d), find the impedance R_2 of the inserted λ/4 transformer.



(30%) **4.** A 50-Ω transmission line is connected to a (100+j120) Ω load. Design the matching network based on the following methods.

(a) (20%) Design a double-stub matching network using a short circuited stub. Simply SKETCH the design procedure on the simplified Smith chart step by step. You need to provide both solutions.

(b) (10%) Sketch TWO kinds of matching network using lumped elements (*L*, *C*). At least two lumped elements are used (*L*-type、 *π*-type、*T*-type、*ladder*-Type). Also sketch the simplified Smith chart to explain your design concept. (You don't need to find the element values)

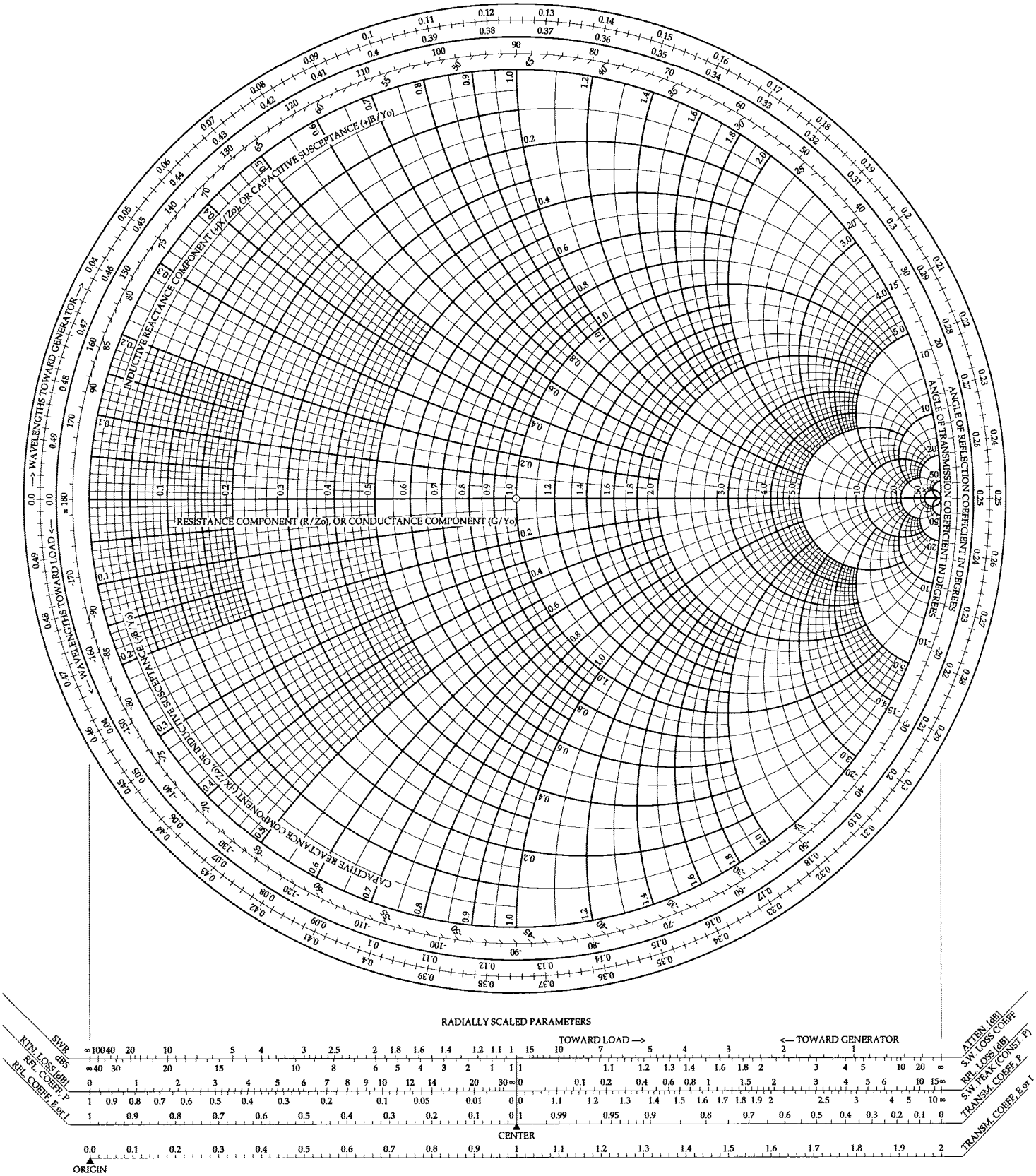
(8%) **5. Bonus**

(a) (4%) What is the advantage of the 4-element ladder-type over the 2-element L-type matching network ?

(b) (4%) What is the advantage of the double-stub matching network over the single-stub matching network ?

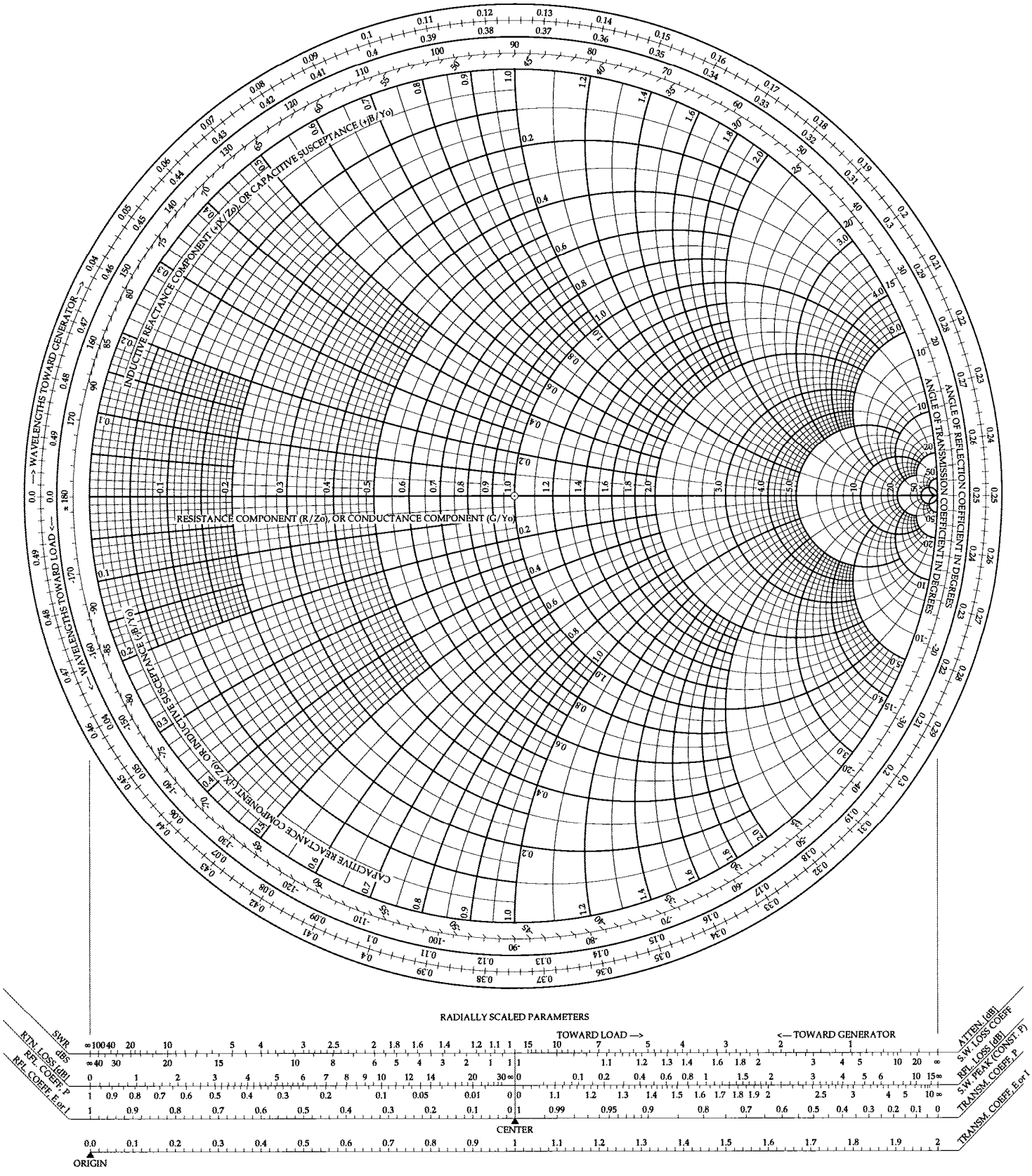
The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

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