MENOUFIA UNIVERSITY — **Final Exam – 1st Semester, 2019/2020**
Faculty of Electronic Engineering — **Microwave Electronics (EC430), 4th Year**
Dept. of Electron.& Commun. Engg — **13/1/2020** — **Time: 10 am to 1 pm** — **Assoc.Prof. Dr. A. Shalaby**

Answer the following questions (The exam is two pages, two Smith charts and formula sheet): ***(Full Marks:70)***

(Note: attach Smith charts with your booklet)

1.a) A microwave transistor has the following S parameters $(Z_0 = 50\ \Omega)$: $S_{11} = 0.8\angle -90^\circ$, $S_{21} = 5.1\angle 80^\circ$, $S_{12} = 0.3\angle 70^\circ$, $S_{22} = 0.62\angle -40^\circ$. Plot the stability circles of this transistor on the Smith chart and show the stable regions. Use horizontal lines (≡) for shading the stable region of the input stability circle and vertical lines (‖) for shading the stable region of the output stability circle. (7)

b) In a designed microwave transistor amplifier for a specified gain the center and the radius of the constant gain input circle are given by: $C_S = 0.706\angle 120^\circ$, $R_S = 0.166$. The FET has the following scattering parameters $(Z_0 = 50\Omega)$: $S_{11} = 0.75\angle -120^\circ$, $S_{21} = 2.5\angle 80^\circ$, $S_{12} = 0.0$, $S_{22} = 0.60\angle -70^\circ$. Calculate the gain of the input matching circuit in dB without using Smith chart. (6)

c) A GaAs FET has the following the scattering and noise parameters at 8.0 GHz $(Z_0 = 50\,\Omega)$: $S_{11} = 0.7\angle -110^\circ, S_{21} = 3.5\angle 60^\circ, S_{12} = 0, S_{22} = 0.8\angle -70^\circ$, $F_{\min} = 2.5\,dB$, $\Gamma_{opt} = 0.70\angle +120^\circ$, $R_N = 15\,\Omega$. What are the values of Γ_S and Γ_L to obtain a low-noise amplifier with minimum noise figure, and maximum possible gain? Calculate the unilateral transducer power gain (G_{TU}) in dB without using Smith chart. (7)

2.a) Sketch the circuit of a Colpitts oscillator using a common emitter transistor and derive the frequency of oscillation. (6)

b) A one-port oscillator uses a negative-resistance diode having $\Gamma_{in} = 2.05\angle -60^\circ$ $(Z_0 = 50\Omega)$ at its desired operating point, for $f = 6$ GHz. Design the matching circuit for a load of 50Ω using open-circuited shunt stub (take the upper intersecting point on the unity circle of the Smith chart). Sketch the circuit and show the lengths of the series and shunt sections. (7)

c) Sketch the circuit diagram of a single-ended diode mixer and define the conversion loss. A down converter has a conversion loss of 4.17 dB and RF and LO isolation of 20 dB. If the RF input power is 0 dBm, what are the IF output power and the RF power leaked into the LO port? (7)

3.a) Sketch the schematic diagram of a two-cavity klystron and derive an expression for the bunching parameter (X). Using this result find an expression for the optimum distance (L_{opt}) between the two cavities. (7)

b) A reflex klystron operates under the following conditions: $V_o = 600\ V$, $V_r = 250\ V$, $f_r = 9\ GHz$, *and* $X'J_1(X') = 1.25$. $e/m = 1.76 \times 10^{11}$ (MKS system). Calculate the value of the repeller space for which the tube can oscillate in $1^3/_4$ mode (n=2) and the electronic efficiency. (6)

c) Show the state of the amplitude and the direction of propagation of each wave of the propagating waves in the TWT. A TWT operates under the following parameters: $V_o = 3\ kV$, $I_o = 30\ mA$, $f = 10\ GHz$ *and* $Z_o = 10\,\Omega$. If the interaction region is 16.24 cm long, find the power gain (in dBs) and the phase velocity of the forward growing wave. (7)

P. T. O. →

4.a) Sketch a top view of a circular magnetron oscillator. Find an expression for the cyclotron angular frequency. A circular magnetron has the following parameters: a = 2 mm, b = 4 mm, B_0 = 0.3 Wb/m^2, and N = 8 cavities. Calculate the period for one complete revolution of the electron and the phase shift between two adjacent cavities for the 4^{th} mode. (7)

b) Write an expression for the capacitance of a varactor diode when a pumping voltage $v_p = V_p \cos \omega_p t$ is applied on the diode. Sketch the equivalent circuit of a parametric amplifier. In an up-converter parametric amplifier; the figure of merit (γQ) is 10 and the ratio of the output frequency over the signal frequency (f_0 / f_s) is 20. Calculate the power gain. What is the power gain as predicted by Manley-Rowe (8)
