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ROYAL AIR FORCE—AIRCRAFT APPRENTICES

No. 1 RADIO SCHOOL, LOCKING

INTERMEDIATE EXAMINATION IN EDUCATIONAL SUBJECTS
SEPTEMBER, 1956 (84TH) ENTRY

JUNE, 1957

BASIC RADIO PRINCIPLES

Time allowed—Three hours

SIX *questions to be attempted*

All questions carry equal marks

[P.T.O.

1.

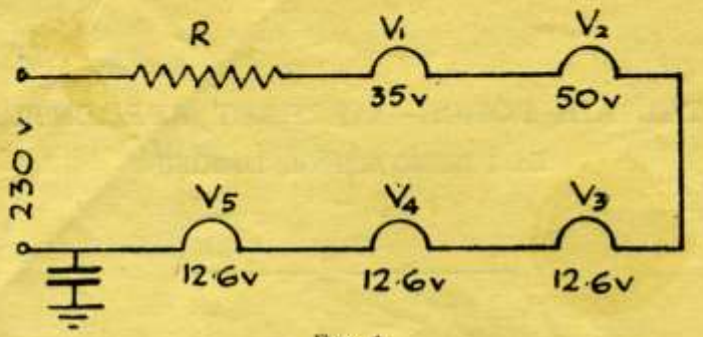

FIG. 1

(*a*) Figure 1 is the valve heater circuit of a universal receiver which is to be operated from a d.c. supply of 230 volts. Each of the five valves is designed to take a heater current of 0·15 amp; their working voltages are as shown. The resistor R is to adjust the circuit current to 0·15 amp. Calculate :—

(i) the resistance of R (to the nearest ohm),

(ii) the power dissipated in R, and

(iii) the power taken from the supply.

(*b*) It is desired to add a dial light to the circuit of Figure 1. The bulb to be used, rated at 7·5 volt, 0·1 amp, is to be wired in parallel with a resistor *r*, which is connected between V_2 and V_3. The parallel resistor *r* is chosen so that the correct current is passed by the dial light. Calculate :—

(i) the resistance of *r*,

(ii) the power dissipated in *r*, and

(iii) the new value of R (to nearest ohm).

2. (*a*) On the same set of axes draw hysteresis loops for soft iron and steel.

(*b*) Explain the following terms, and by reference to the loops required at (*a*) above, compare their values for soft iron and steel—

(i) Remanence (Retentivity).

(ii) Coercivity.

(*c*) Give reasons why—

(i) self-excited dynamos have pole-pieces of high remanence ;

(ii) steel is far better than soft iron for the construction of permanent magnets ;

(iii) all modern audio-frequency magnetic materials have hysteresis loops of small area.

3. (*a*) Explain with the aid of a diagram the action of a thermo-couple meter.

(*b*) What are the relative advantages and disadvantages of the thermo-meter over the moving-coil type for current measurement ?

(*c*) A moving coil milliammeter of resistance 75 ohms and full scale deflection 1mA is to be converted for use as a 0–100 voltmeter.

(i) Draw a suitable circuit, and indicate the polarity of the meter and of the input to be measured.

(ii) Calculate the resistance and wattage of the multiplier to be used.

(iii) What is the sensitivity of this voltmeter ?

4. (*a*) By reference to the magnetic field of a solenoid, explain why any variations in current through the solenoid are opposed.

(*b*) A coil of inductance 5 henry and resistance 10 ohms is connected through a switch to a d.c. supply of 20 volts. Explain, with the aid of a graph, and with reference to the time constant of the circuit, the sequence of current variations when the switch is closed for 5 seconds and then opened. Calculate :—

(i) the greatest value of circuit current,

(ii) the time constant of the circuit, and

(iii) the value of current 0·5 sec after the circuit is made.

5. (*a*) What is meant by :—

(i) the *peak value* of an alternating voltage ?

(ii) the *Root Mean Square* value of an alternating current ?

(iii) the *Power Factor* of a circuit ?

(*b*) Explain why the *true power* in a purely inductive circuit is zero whereas the *apparent power* is not zero.

(*c*) A resistor of 1,000 ohms is connected in series with a generator of negligible internal resistance. If the output of the generator has a peak value of 200 volts and frequency of 50 c/s, calculate to the nearest mA the instantaneous value of circuit current 2·5 milliseconds after the voltage has reached a peak value.

6. A coil of inductance 300 μH and of radio-frequency resistance 5 ohms is connected in parallel with a capacitor of 0·0003 μF. Calculate for this circuit :—

(*a*) the resonant frequency (to the nearest kilocycle),

(*b*) the dynamic resistance,

(*c*) the Q-factor at the resonant frequency, and

(*d*) the bandwidth.

7. (*a*) Explain how the " no load " terminal voltage of a d.c. shunt-wound generator builds up when the machine is started.

(*b*) Draw a typical curve of output voltage against load current for a simple shunt-wound machine run at constant speed. How may the machine be modified so that the output characteristic is level ?

(*c*) What do you understand by the term " armature reaction " ? Explain two methods by which this effect may be counteracted in a generator.

8. (*a*) Explain the action of the screen grid of a tetrode valve, and describe its effect on the electrode capacitance between anode and grid. Support your answer by giving typical values for this capacitance in small triode and tetrode valves.

(*b*) On the same set of axes draw typical anode characteristics for a tetrode and for a pentode. Explain fully any difference between the curves.

(*c*) Draw families of curves to show how the relationship between space current of a pentode and anode voltage is controlled by :—

(i) control grid voltage,

(ii) screen voltage.

Why is space current passed by the valve when the anode voltage is zero ?

9.

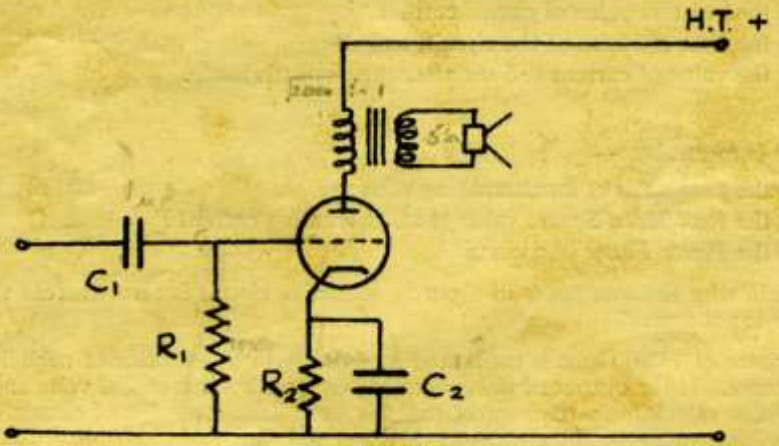

FIG. 2

Figure 2 shows an A.F. output stage. The loudspeaker has an impedance of 5 ohms and the valve has constants, $\mu = 25$ and $g_m = 5$mA/volt.

(*a*) Calculate :—

(i) the turns ratio of the transformer for maximum output.

(ii) the value and wattage of the cathode resistor R_2 if a bias of 20 volts is required when the anode current is 40mA.

(*b*) Explain the functions of the components R_1, C_1 and C_2. Indicate suitable values for these components and give reasons for the values chosen. How do the capacitors C_1 and C_2 differ in type ? Why is this ?