इन्जीनियरिंग सेवा परीक्षा, ...2009
Engineering Service Examination,

Serial No. 65301 A–FTF–J–FUB

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper—II

(Conventional)

Time Allowed : Three Hours *Maximum Marks : 200*

INSTRUCTIONS

Candidates should attempt Question No. 1 which is compulsory, and FOUR more questions taking TWO each from Section—A and Section—B.

The number of marks carried by each question is indicated at the end of the question.

Answers must be written in ENGLISH.

Assume any data, if required and indicate the same clearly.

Wherever a question is attempted, all its subdivisions must be attempted.

Unless otherwise indicated, symbols and notations have their usual meaning.

Some useful constants are given below :

Electron charge	:	$e = 1{\cdot}6 \times 10^{-19}$ coulomb
Electron mass	:	$m = 9{\cdot}1 \times 10^{-31}$ kg
Planck's constant	:	$h = 6{\cdot}625 \times 10^{-34}$ J-s
Velocity of light	:	$c = 3 \times 10^{8}$ m/s
Universal constant of gravitation	:	$G = 6{\cdot}668 \times 10^{-11}$ $m^3/kg\text{-}s^2$
Mass of Earth	:	$M = 5{\cdot}997 \times 10^{24}$ kg
Radius of Earth	:	$R = 6378$ km
Permeability of vacuum	:	$\mu_o = 4\pi \times 10^{-7}$ H/m
Permittivity of vacuum	:	$\varepsilon_o = \frac{10^{-9}}{36\pi}$ F/m

1. (a) For a fullwave rectifier with a capacitor filter, show that the ripple voltage—V_r is inversely proportional to the capacitor C and is proportional to the load current I_{dc}. Calculate the value of 'V_r' when C = 100 μF and I_{dc} = 10 mA. The a.c. input voltage to the rectifier is given by $v = V_m \sin 314t$. 8

(b) Obtain the minimal SOP expression for $Y(A, B, C, D) = \Sigma m(2, 3, 5, 7, 8, 9, 11, 12, 13, 14, 15) + d(2, 4)$ using K-map. Realize the expression using 2 input NAND gates only. 8

(Contd.)

(c) Design a mod-7 asynchronous up counter using JK flip-flops. Write the state diagram and the timing diagram for the same. The counter counts during +ve edges of the clock. 8

(d) State and explain minimum phase and non-minimum phase transfer functions with examples. 8

(e) Obtain the overall transfer function of an armature controlled d.c. shunt motor. Explain the difference between armature controlled and field controlled d.c. motor. 8

(f) An optical fibre has a core refractive index of 1·45 and a cladding refractive index of 1·4. Assuming ray theory of analysis, determine the following :

(i) Numerical aperture of the fibre.

(ii) Acceptance angle in air for fibre.

(iii) Critical angle at core-cladding interface. 8

(g) (i) Assuming a geosynchronous satellite global beam covering all visible earth surface with 100% efficiency, calculate its G/T ratio, if earth radius is 6400 km and altitude of satellite is 6000 km (Noise temp. of satellite antenna is 290° K). 6

(ii) What are the classification of satellites in terms of distance from earth and position from earth ? 2

(h) Microwave signal of 9·2 GHz is propagating in dominant mode through a rectangular waveguide filled with air. If inside dimensions of the waveguide are 2 cm × 1 cm, calculate the following :

(i) cut off frequency

(ii) guide wavelength

(iii) phase velocity

(iv) characteristic impedance.

Sketch also the method of excitation of TE_{10} mode and TE_{20} mode in a rectangular waveguide.

6+2

(i) Convert the following :

(i) decimal number into octal

$(5621 \cdot 125)_{10}$

(ii) hexadecimal number into octal and into binary

$(5621)_{16}$. 4+2+2

(j) Write a 'C' program to print first twenty Fibonacci numbers (Fib (i)) using the formula :

$$\text{Fib (i)} = \text{Fib (i} - 1) + \text{Fib (i} - 2)$$

where i is an integer ≥ 0.

It is given that

$$\text{Fib (0)} = \text{Fib (1)} = 1.$$ 8

SECTION—A

2. (a) Design a self bias circuit for a CE amplifier using an npn transistor with $\beta = 100$. The other details are : $V_{CC} = 12$ V, $V_{CEQ} = 6$ V, $I_{CQ} = 4$ mA. 10

(b) Design an op-amp waveform generating circuit to produce the waveform given in Fig. 2(b). Explain the circuit operation with other relevant waveform. 10

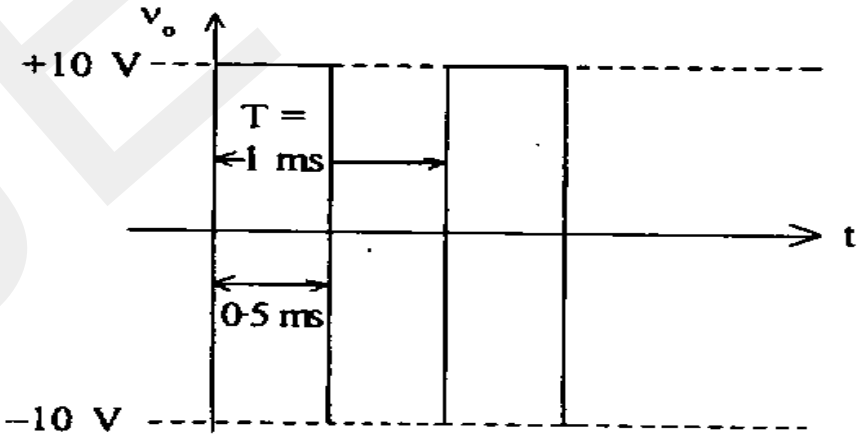


Fig. 2(b)

(Contd.)

(c) Identify the logic gate shown in Fig. 2(c). Explain the operation of the same with the help of truth-table. 10

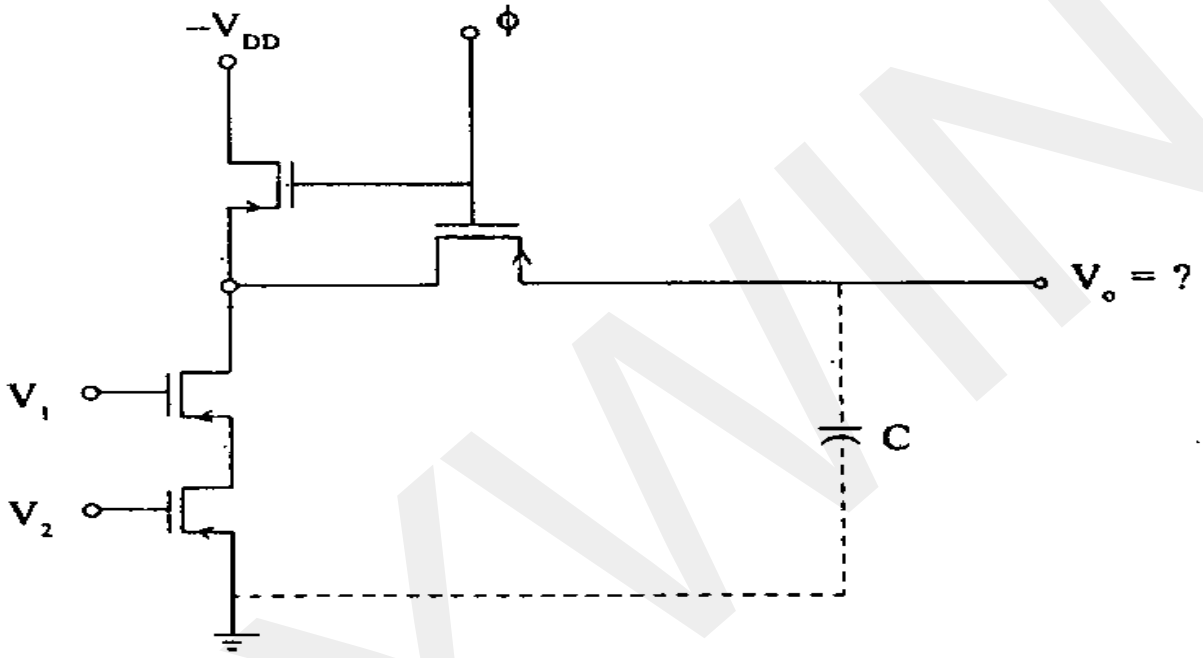


Fig. 2(c)

3. (a) Write the counting sequence of a 4 bit down synchronous counter. Design the same using –ve edge triggered J-K Flip-Flops. 10

(b) Design a Schmitt trigger circuit using an op-amp which has a maximum output voltage of ±10 V. The 'hysteresis'—V_H should be = 0·4 V. Explain the working of the circuit with the transfer characteristics. Use a reference voltage V_R = 2 V. 10

(Contd.)

(c) Implement the following expressions using CMOS-AOI logic circuits. Verify the circuit operation with the help of truth table :

(i) $Y = A + BC$

(ii) $Y = \overline{AB + CD}$. 10

4. (a) Explain the difficulties involved in the application of Routh-Hurwitz criterion and also bring out limitations. Find the stability of the control system whose characteristic equation is given by

$$(s - 1)^2 (s + 2) (s + 1) = 0.$$ 10

(b) Explain the effect of additional poles and zeros of G(s) H(s) on the shape of the Nyquist plot. Sketch the Nyquist diagram and determine stability of the transfer function :

(i) $G(s)\,H(s) = \dfrac{s}{1 - 0{\cdot}2s}$

(ii) $G(s)\,H(s) = \dfrac{s+2}{(s+1)(s-1)}$. 10

(c) Obtain the overall transfer function C/R from the signal flow graph—Fig. 4(c). 10

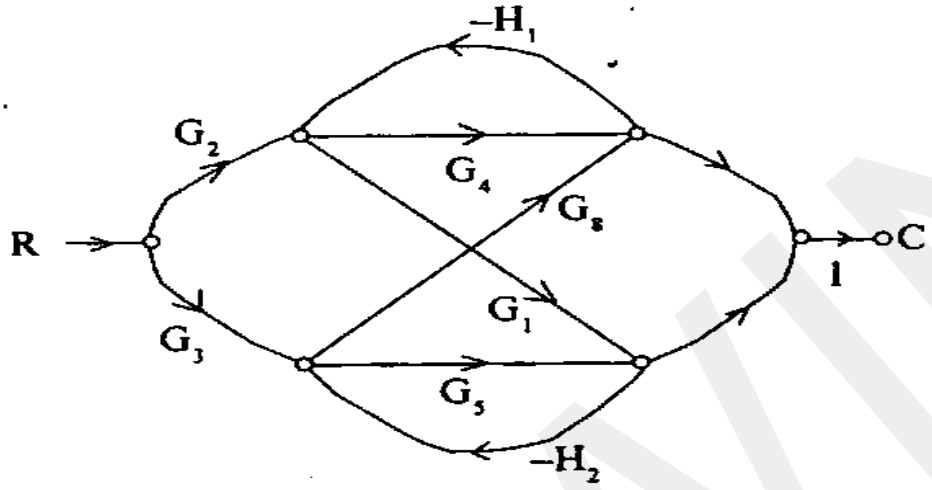


Fig. 4(c)

SECTION—B

5. (a) A voice grade telephone circuit has to transmit audio signal in digital signal form. Suggest and explain the scheme for the same with suitable block diagram. Calculate the data rate if an ADC of 12 bits is used in your scheme. 10

(b) An optical fiber link has the following details :

Laser diode output = 3 dBm

In GaAs APD sensitivity = –32 dBm

Optical fiber attenuation = 0·25 dB/km

Connector loss at each end = 1 dB

Power margin = 6 dB.

Calculate the link distance. Represent this link loss budget graphically. 10

(c) With the help of a block diagram explain the working of a superheterodyne AM receiver. 10

(Contd.)

6. (a) Sketch the structure, field distribution and doping profile of an IMPATT diode. With the help of appropriate voltage and current plots in IMPATT diode, show how negative resistance is obtained in it. 14

(b) In the case of an IMPATT having carrier drift velocity $v_d = 4 \times 10^5$ m/sec

Drift region length L = 12 μm

Breakdown voltage $V_{bd} = 90$ V

Maximum operating voltage $V_{max} = 100$ V

Maximum operating current $I_{max} = 100$ mA

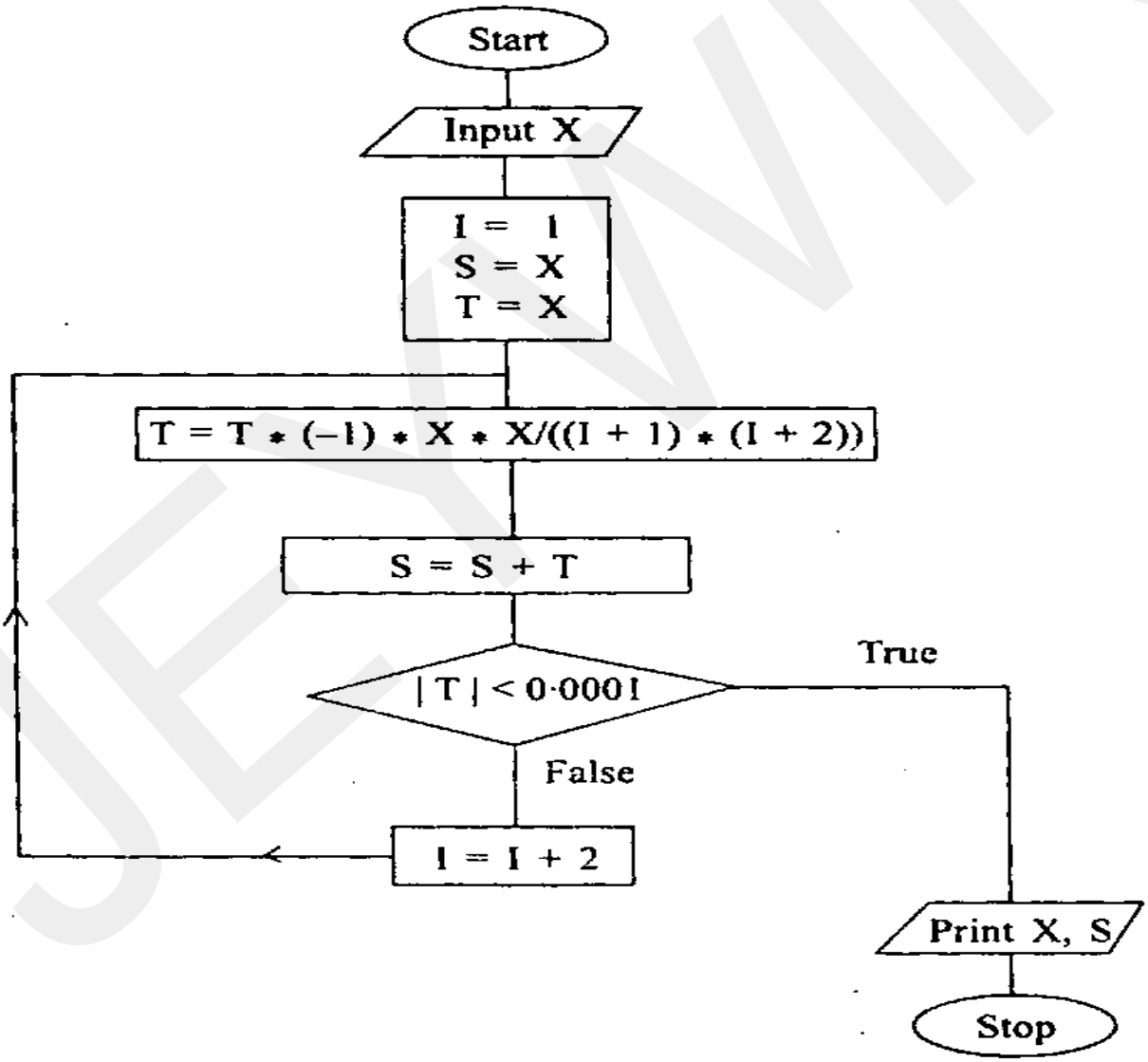
Efficiency $\eta = 10\%$.

Determine the resonant frequency and maximum CW output power. 6

(c) Sketch an antenna radiation pattern in polar co-ordinates. With reference to the antenna radiation pattern, show side lobe level, half power beam width and null width. Define gain of an antenna. How is it related to effective aperture area ? What is difference between isotropic antenna and omnidirectional antenna ? 7

(d) A parabolic antenna is operating at S-band mid frequency. If the frequency is now shifted to X-band mid frequency, determine the approximate increase in gain in dB. 3

7. (a) What is done by the following program flow chart ? Give a trace (print out) of all the variables till i = 5 for X = 0·5. 10



(b) What is done by the following assembly language program ? Explain. 10

```
        LXI     H, TABLTOP
        MOV     C, M
LP2     INX     H
        MOV     E, M
        INX     H
        MOV     D, M
        INX     H
        MOV     B, M
        INX     H
        MVI     M, OO
LP1     MOV     A, E
        SUB     B.
        MOV     E, A
        MOV     A, D
        SBI     OO
        JM      LBL1
        INR     M
        MOV     D, A
        JMP     LP1
```


(Contd.)

```
LBL1  MOV    A, E
      ADD    B
      INX    H
      MOV    M, A
      DCR    C
      JNZ    LP2
      RET
```

Programme variable :

TABLTOP EQU 19ϕϕH.

(c) How many interrupt lines are there in Intel 8085 ? Name them in order of priority. Give their restart location also. 10