



# ESE 2019

PRELIMINARY EXAMINATION



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## ELECTRONICS & COMMUNICATION ENGINEERING

# ESE TOPICWISE OBJECTIVE SOLVED PAPER-II

Detailed Solution | Topicwise Description | Fully Revised & Updated

**ESE TOPICWISE OBJECTIVE SOLVED PAPER-II**  
**ELECTRONICS & COMMUNICATION ENGINEERING**



UPSC Engineering Service Examination 2019

# ELECTRONICS AND COMMUNICATION ENGINEERING

ESE TOPICWISE OBJECTIVE  
SOLVED PAPER-II

From (1991 – 2018)



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**Second Edition** : 2018

# PREFACE

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It is an immense pleasure to present topic wise previous years solved paper of Engineering Services Exam. This booklet has come out after long observation and detailed interaction with the students preparing for Engineering Services Exam and includes detailed explanation to all questions. The approach has been to provide explanation in such a way that just by going through the solutions, students will be able to understand the basic concepts and will apply these concepts in solving other questions that might be asked in future exams.

Engineering Services Exam is a gateway to a immensely satisfying and high exposure job in engineering sector. The exposure to challenges and opportunities of leading the diverse field of engineering has been the main reason for students opting for this service as compared to others. To facilitate selection into these services, availability of arithmetic solution to previous year paper is the need of the day. Towards this end this book becomes indispensable.

**Mr. Kanchan Kumar Thakur**  
Director–IES Master



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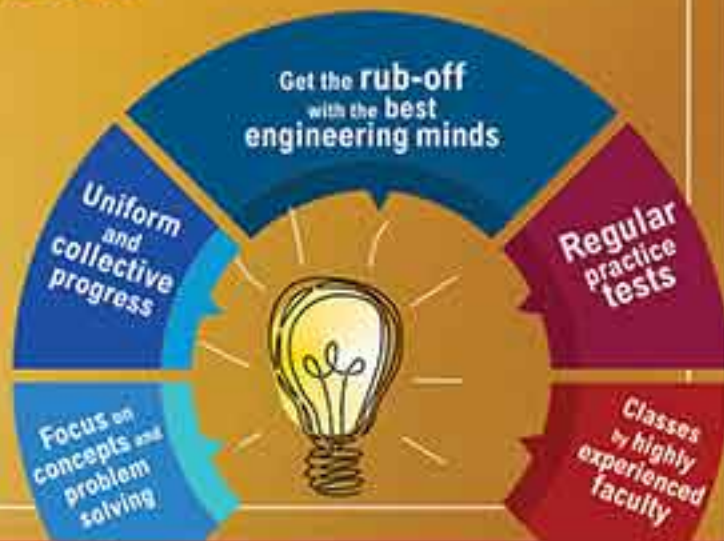
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**Note:** Direction of all **Assertion Reasoning (A-R)** type of questions covered in this booklet is as follows:

**DIRECTIONS:**

The following four items consist of two statements, one labelled as '**Assertion A**' and the other labelled as '**Reason R**'. You are to examine these two statements carefully and select the answer to these two statements carefully and select the answer to these items using the codes given below:

- (a) Both A and R are individually true and R is the correct explanation of A
- (b) Both A and R are individually true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true.

**Note:** Direction of all **Statement-I** and **Statement-II** type of questions covered in this booklet is as follows:

**DIRECTION:**

Following items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the code given below:

- (a) Both Statement : (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true.

# CONTENTS

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1. Control System .....	01–172
2. Electromagnetic Field Theory .....	173–366
3. Communication Systems .....	367–456
4. Computer Organization and Architecture .....	457–502
5. Advanced Electronics .....	503–507
6. Advance Communication Systems .....	508–549
7. Signal and Systems .....	550–678

# Unit

# 1

# Control System

## SYLLABUS

*Signal flow graphs, Routh-Hurwitz criteria, root loci, Nyquist/Bode plots  
Feedback systems-open & close loop types, stability analysis, steady state,  
transient and frequency response analysis; Design of control systems,  
Compensators, elements of lead/lag compensation, PID and industrial controllers.*

## ■ ***Contents***

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1.	Basics of Control System, Block Diagram and Signal Flow Graph -----	01-16
2.	Modelling and Response of Physical Systems -----	17-29
3.	Time Response Analysis -----	30-66
4.	Stability and Routh-Hurwitz Criterion -----	67-84
5.	Root Locus Technique -----	85-98
6.	Frequency Response Analysis -----	99-136
7.	Controllers and Compensators -----	137-164
8.	State Variable Analysis -----	165-172

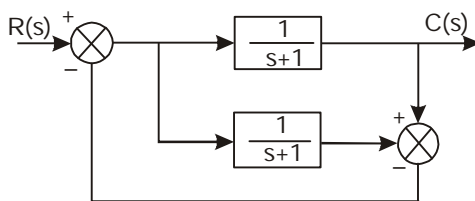
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# Basics of Control System, Block Diagram and Signal Flow Graph

IES – 2018

- Consider the following statements for signal flow graph:
  - It represents linear as well as non linear systems.
  - It is not unique for a given system.
 Which of the above statements is/are correct?
  - 1 only
  - 2 only
  - Both 1 and 2
  - Neither 1 nor 2
- The closed-loop transfer function  $C(s)/R(s)$  of the system represented by the block diagram in the figure is



- $\frac{1}{(s+1)^2}$
- $\frac{1}{(s+1)}$
- $s+1$
- 1

IES – 2015

- The Laplace transform of  $e^{-2t} \sin 2\omega t$  is

- $\frac{2s}{(s+2)^2 + 2\omega^2}$
- $\frac{2\omega}{(s-2)^2 + 4\omega^2}$
- $\frac{2\omega}{(s+2)^2 + 4\omega^2}$
- $\frac{2s}{(s-2)^2 + 2\omega^2}$

IES – 2013

- The open-loop transfer function of a unity feedback control system is

$$G(s) = \frac{1}{(s+2)^2}$$

The closed loop transfer function poles are located at:

- 2, -2
  - 2, -1
  - 2, +2
  - $-2 \pm j1$
- In control systems, excessive bandwidth is NOT employed because:
    - noise is proportional to bandwidth
    - it leads to low relative stability
    - it leads to slower response
    - noise is proportional to the square of the bandwidth

IES – 2012

- A system is described by the transfer function  $G(s) = \frac{2s+5}{(s+5)(s+4)}$ . The dc gain of the



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system is

- (a) 0.25 (b) 0.5  
(c) 1 (d)  $\infty$

7. The sensitivity  $S_K^T$  of transfer function

$T = \frac{(1+2K)}{(3+4K)}$  with respect to the parameter K is given by

- (a)  $\frac{K}{3+K^2}$   
(b)  $\frac{3K}{2+4K+K^2}$   
(c)  $\frac{2K}{3+10K+8K^2}$   
(d)  $\frac{4K}{2+5K+7K^2}$

IES – 2011

8. What is the unit impulse response of the system shown in figure for  $t \geq 0$ ?



- (a)  $1 + e^{-t}$  (b)  $1 - e^{-t}$   
(c)  $e^{-t}$  (d)  $-e^{-t}$

9. Given the differential equation model of a physical system, determine the time constant of the system

$$40 \frac{dx}{dt} + 2x = f(t)$$

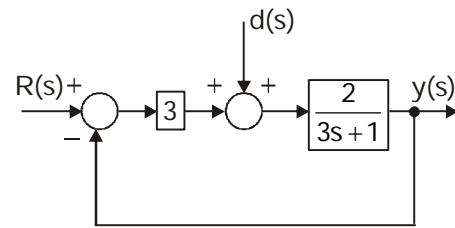
- (a) 10 (b) 20  
(c) 1/10 (d) 4

IES – 2010

10. A linear time-invariant system is initially at rest, when subjected to a unit-step input, gives a response  $y(t) = te^{-t}, t > 0$ . The transfer function of the system is:

- (a)  $\frac{1}{(s+1)^2}$  (b)  $\frac{1}{s(s+1)^2}$   
(c)  $\frac{s}{(s+1)^2}$  (d)  $\frac{1}{s+1}$

- 11.



The transfer function from  $d(s)$  to  $y(s)$  is:

- (a)  $\frac{2}{3s+7}$  (b)  $\frac{2}{3s+1}$   
(c)  $\frac{6}{3s+7}$  (d)  $\frac{2}{3s+6}$

IES – 2009

12. Consider the function  $F(s) = \frac{\omega}{s^2 + \omega^2}$  where  $F(s)$  is the Laplace transform of  $f(t)$ . What is the steady state value of  $f(t)$ ?

- (a) Zero  
(b) One  
(c) Two  
(d) A value between  $-1$  and  $+1$

13. What is the characteristic of a good control system?

- (a) Sensitive to parameter variation  
(b) Insensitive to input command  
(c) Neither sensitive to parameter variation nor sensitive to input commands.  
(d) Insensitive to parameter variation but sensitive to input commands.

14. A negative-feedback closed-loop system is supplied with an input of 5V. The system has a forward gain of 1 and a feedback gain of 1. What is the output voltage?

- (a) 1.0 V (b) 1.5 V  
(c) 2.0 V (d) 2.5 V

15. In closed loop control system, what is the sensitivity of the gain of the overall system, M to the variation in G?

- (a)  $\frac{1}{1+G(s)H(s)}$  (b)  $\frac{1}{1+G(s)}$   
(c)  $\frac{G(s)}{1+G(s)H(s)}$  (d)  $\frac{G(s)}{1+G(s)}$

## ANSWER KEY

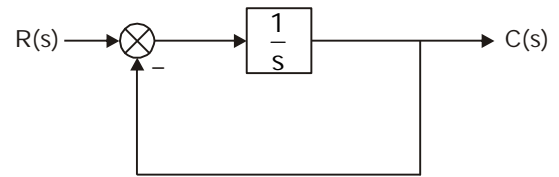
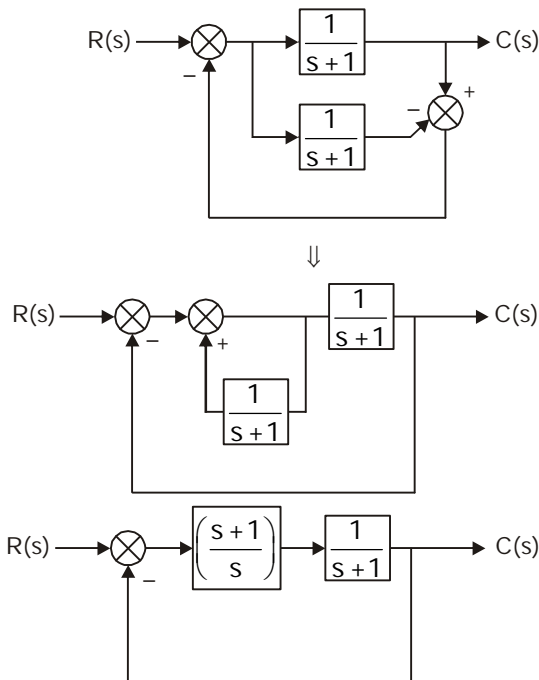
1. (c)	10. (c)	19. (d)	28. (b)	37. (b)	46. (b)
2. (b)	11. (a)	20. (c)	29. (c)	38. (a)	47. (a)
3. (c)	12. (d)	21. (b)	30. (a)	39. (d)	48. (a)
4. (d)	13. (d)	22. (c)	31. (a)	40. (d)	49. (a)
5. (a)	14. (d)	23. (b)	32. (b)	41. (d)	
6. (a)	15. (a)	24. (b)	33. (a)	42. (c)	
7. (c)	16. (c)	25. (d)	34. (a)	43. (d)	
8. (b)	17. (c)	26. (b)	35. (b)	44. (a)	
9. (b)	18. (a)	27. (b)	36. (c)	45. (b)	

SOLUTION... 

Sol-1: (c)

The signal flow graph approach is valid for linear as well as non-linear systems. One system can have different signal flow graph according to the order in which the equations are used to define the variable written on the left hand side. So it is not unique for a given system.

Sol-2: (b)



$$\frac{C(s)}{R(s)} = \frac{\frac{1}{s}}{1 + \frac{1}{s}} = \left( \frac{1}{s+1} \right)$$

Sol-3. (c)

$$L[e^{-2t} \sin 2\omega t] = ?$$

$$L[\sin 2\omega t] = \frac{2\omega}{s^2 + (2\omega)^2} = \frac{2\omega}{s^2 + 4\omega^2}$$

$$\therefore L[e^{-2t} \times \sin 2\omega t] = \frac{2\omega}{(s+2)^2 + 4\omega^2}$$

Sol-4. (d)

Closed loop poles are roots of characteristic equation  $1 + G(s)H(s) = 0$

$$\text{or, } 1 + G(s) = 0 \quad \{\text{as } H(s) = 1\}$$

$$\text{or, } 1 + \frac{1}{(s+2)^2} = 0$$

$$\text{or, } (s+2)^2 + 1 = 0$$

$$\text{or, } s^2 + 4s + 5 = 0$$

$$\text{or, } s = \frac{-4 \pm \sqrt{16 - 4 \times 1 \times 5}}{2}$$

$$= \frac{-4 \pm \sqrt{-4}}{2} = (-2 \pm j)$$

**Sol-5. (a)**

Noise is proportional to bandwidth as

$$P = K.T(B)$$

Where  $B =$  Bandwidth

It is clear that as Bandwidth increases, noise also increases.

**Sol-6. (a)**

$$G(s) = \frac{2s+5}{(s+5)(s+4)}$$

$$= \frac{5\left(1 + \frac{2}{5}s\right)}{5 \times 4 \left(1 + \frac{s}{5}\right)\left(1 + \frac{s}{4}\right)}$$

To find DC gain – first arrange system in time constant form and then put

$$s = 0 \text{ as for DC, } f = 0 \Rightarrow \omega = 0 \Rightarrow s = j\omega = 0$$

$$|G(s)|_{s=0} = \frac{5(1+0)}{5 \times 4(1+0)(1+0)} = 0.25$$

**Sol-7. (c)**

$$s_K^T = \frac{\partial T / T}{\partial K / K} = \frac{K}{T} \cdot \frac{\partial T}{\partial K}$$

$$= \frac{K(3+4K)}{1+2K} \times \frac{(0+2)(3+4K) - (1+2K)(0+4)}{(3+4K)^2}$$

$$= \frac{K(3+4K)}{(1+2K)} \times \frac{6+8K-4-8K}{(3+4K)^2}$$

$$= \frac{2K}{(1+2K)(3+4K)}$$

$$= \frac{2K}{8K^2 + 10K + 3}$$

**Sol-8. (b)**

$$\text{Transfer Function} = \frac{1}{(s+1)} \times \frac{1}{s} = \frac{1}{s(s+1)}$$

$$\text{Impulse response} = L^{-1} \left\{ \frac{1}{s(s+1)} \right\}$$

$$= L^{-1} \left\{ \frac{1}{s} - \frac{1}{(s+1)} \right\}$$

$$= (1 - e^{-t})u(t)$$

**Sol-9. (b)**

$$40 \cdot \frac{dx}{dt} + 2x = f(t)$$

Applying Laplace Transform on both sides

$$40sX(s) + 2X(s) = F(s)$$

$$\text{or, } \frac{X(s)}{F(s)} = \frac{1}{40s+2} = \left(\frac{1}{40}\right) \frac{1}{s + \frac{1}{20}}$$

$$\text{or, } X(s) = \left(\frac{1}{40}\right) \frac{1}{s + \frac{1}{20}}$$

$$\text{or, } x(t) = (1/40) \cdot e^{-(t/20)}$$

Time constant = 20 sec.

**Sol-10. (c)**

$$y(t) = te^{-t}$$

Applying Laplace Transform

$$Y(s) = L\{y(t)\} = \frac{1}{(s+1)^2}$$

$$r(t) = u(t)$$

$$R(s) = L\{u(t)\} = 1/s$$

$$\text{Transfer Function} = \frac{Y(s)}{R(s)} = \frac{s}{(s+1)^2}$$

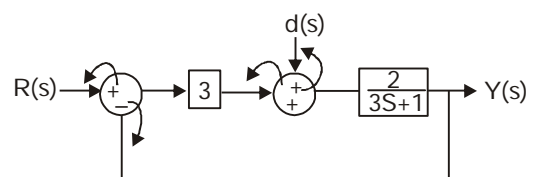
**Sol-11. (a)**To calculate  $\frac{y(s)}{d(s)}$ 

Step 1: Put other inputs and outputs which are irrelevant as zero.

Step 2. Take out all the polarities from the mixer.

Step 3. Draw the block diagram again and insert the polarities.

Step 4. Find the transfer function.



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