BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: VIth Date: 25/04/2022 (MORNING)

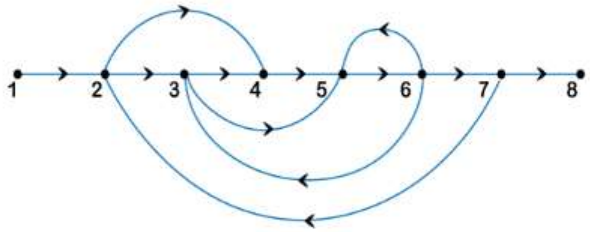
Subject with Code: EE351 CONTROL THEORY

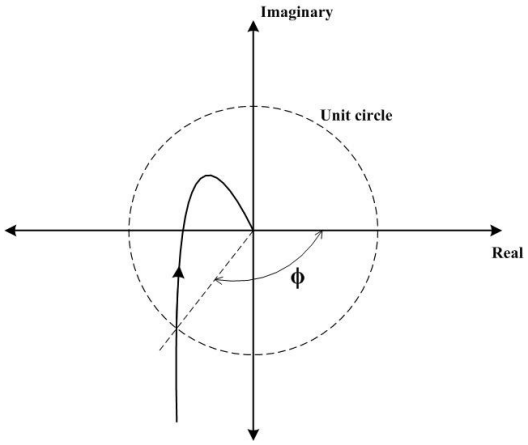
Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

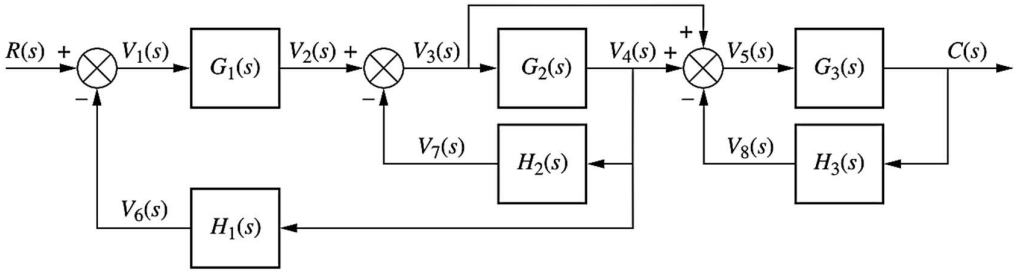
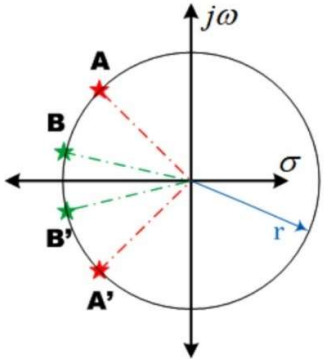
INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY MESRA
END SEMESTER EXAMINATION
EE351 CONTROL THEORY

	SECTION-A Multiple Choice Questions. All questions are mandatory.	[30]
1	In an open loop system: (a) output is independent of input (b) output in dependent on input (c) only some parameters have effect on output (d) none of these	[1.5]
2	Which of the following will increase because of negative feedback: (a) overall gain (b) disturbances (c) bandwidth (d) stability	[1.5]
3	The negative feedback closed-loop system was subjected to 15V. The system has a forward gain of 2 and a feedback gain of 0.5. Determine the output voltage and the error voltage. (a) 15V, 10V (b) 6V, 5V (c) 15V, 7.5V (d) 5V, 10V	[1.5]
4	Find the overall transfer function of the given signal flow graph.  (a) $\frac{G_1G_2G_3}{1+G_1H_1+G_3H_2+G_1H_1G_3H_2}$ (b) $\frac{G_1G_2G_3}{1+G_1H_1+G_3H_1+G_1H_1G_3H_2}$ (c) $\frac{G_1G_2G_3}{1+G_1H_1+G_2H_2+G_2H_1G_3H_2}$ (d) $\frac{G_1G_2G_3}{1+G_2H_2+G_3H_2+G_1H_1G_3H_2}$	[1.5]
5	The impulse response of an RL circuit is: (a) parabolic function (b) rising exponential function (c) oscillatory sinusoid (d) decaying exponential function	[1.5]
6	If the roots of the characteristic equation, $s^3 + 3s^2 + 4s + A = 0$, lie in the left half of the s-plane, the value of A should be: (a) A>12 (b) 0<A<12 (c) A=12 (d) 5<A<12	[1.5]
7	The most powerful controller is: (a) PD (b) PI (c) PID (d) none of these	[1.5]
8	The signal flow graph shown in the figure has:  (a) forward path = 2, loops = 4, and non-touching loops = 0 (b) forward path = 3, loops = 4, and non-touching loops = 0 (c) forward path = 3, loops = 3, and non-touching loops = 0 (d) none of these	[1.5]
9	Which of the following is exhibited by Root locus diagrams? (a) The poles of the transfer function for a set of parameters (b) bandwidth of the system (c) step response of the system (d) impulse response of the system	[1.5]
10	Consider the following statements with respect to the feedback of the control systems. A. Feedback can improve stability or be harmful to stability if it is not properly applied. B. Feedback can always improve stability C. In many situations the feedback can reduce the effect of noise and disturbance on system performance.	[1.5]

	D. In general the sensitivity of the system gain of a feedback system of a parameter variation depends on where the parameter is located. (a) B only (b) A and D (c) A, C and D (d) all the statements	
11	The characteristic equation of a control system is given by $s(s+4)(s^2+2s+3) + k(s+1) = 0$. What are the angles of the asymptotes for the root loci? (a) 0°, 180°, 300° (b) 0°, 120°, 240° (c) 60°, 180°, 300° (d) 120°, 180°, 240°	[1.5]
12	A control system whose step response is $0.5(1-e^{-2t})$ is cascaded to another control block whose impulse response is e^{-t}. What is the transfer function of the cascaded combination? (a) 1/s(s+1) (b)1/(s+3) (c) 1/s(s+1)(s+2) (d) 1/(s+1)(s+2)	[1.5]
13	Which of the following is the strongest tool to determine the stability and transient analysis of a system (a) Routh Hurwitz (b) Root Locus (c) Nyquist Criteria (d) Bode Plot	[1.5]
14	Let Y(s) be the output of a system having transfer function $G(s) = \frac{3-s}{(s+1)(s+3)}$. If $Y(s) = \frac{G(s)}{s}$, then the forced response of the system is: (a) u(t) (b) 2u(t) (c) $u(t)-2e^{-t}+e^{-3t}$ (d) $-2e^{-t}u(t)+e^{-3t}u(t)$	[1.5]
15	The differential equation of a first order linear time invariant system, with output y(t) for input x(t), is given below. $$\frac{dy}{dt} + 3y = 10x(t)$$ The state transition matrix for the system will be: (a) e^{-10t} (b) e^{10t} (c) e^{-3t} (d) e^{3t}	[1.5]
16	If the polar plot of a system, intersects the negative real axis of GH-plane at -0.8, the gain margin of the system will be: (a) 1.25 (b) 0.625 (c) 0.8 (d) 0.2	[1.5]
17	The open loop transfer function, given below, is: $$(s) = \frac{K(s-2)}{s(s+2)(s+4)}$$ (a) stable and minimum-phase (b) stable and non-minimum phase (c) unstable and minimum phase (d) unstable and non-minimum phase	[1.5]
18	The poles of a second order system, lie on the left half of s-plane, only if the gain satisfies the inequality $0<K<10$. Such a system is: (a) Absolutely stable (b) Marginally stable (c) Conditionally stable (d) none of these	[1.5]
19	The polar plot of a system is shown below.  The phase margin of the system is: (a) ϕ (b)180- ϕ (c) 90- ϕ (d) 1/ ϕ	[1.5]
20	An automatic system is: (a) closed loop (b) open loop (c) unstable (d) cheap	[1.5]
	SECTION-B Short answer type questions. Answer any 5 questions	[20]
B1	A linear time invariant system is defined by the differential equation given below:	[4]

	$$7\frac{d^3y}{dt^3} + 2\frac{d^2y}{dt^2} - 3\frac{dy}{dt} + 5y = 25u(t)$$ Define the state variables and formulate the state-space model of the system.	
B2	The open loop transfer function of a unity feedback system is given below: $$G(s) = \frac{K}{s(s+2)(s+4)}$$ For the root locus of the system, calculate: (a) angle of asymptotes (b) intersection point of the asymptotes with the real axis (c) breakaway point (d) intersection point of the root locus branches with the imaginary axis.	[4]
B3	Draw the polar plot of the following system: $$G(s) = \frac{5}{s(s+1)(s+2)}$$ Also, estimate the gain margin of the system.	[4]
B4	Describe the operating principle of incremental encoder and list its various applications.	[4]
B5	Reduce the system, shown in the figure given below, into a single transfer function. 	[4]
B6	(a) The pole locations, in the s-plane, of two second-order systems, namely A and B, are shown in the figure below:  Which system will have better step response? Justify your answer. (b) If a pole is moved along a radial line extending from the origin, what will the responses have in common?	[4]
B7	The open loop transfer function of a unity feedback system is defined below: $$G(s) = \frac{K}{s(s+4)}$$ (a) What value of the gain K will yield a settling time of 6 seconds (assuming 5% tolerance band) and peak overshoot of 20%? (b) For the gain K estimated in part (a) what will be the steady state error of the system for unit step and unit ramp inputs, respectively?	[4]