(3 Hours) **Total Marks: 80**

N.B.:- (1) Question No.**1** is compulsory.

(2) **Attempt** any **Three** questions out of remaining **Five** questions.

(3) Assume suitable data if necessary and justify the same.

Q 1. Answer the following questions. **20**

A) Explain cut off characteristics of HRC fuse.

B) Explain current chopping phenomenon.

C) What is primary and backup protection?

D) Explain construction and working of Isolator

Q 2 a) Explain the working of induction disc relay with neat diagram. **10**

Q 2 b) Discuss various parameters of protective relay. **10**

Q 3 a) Explain with neat diagram the construction and working of SF_6 Circuit Breaker. **10**

Q 3 b) Explain resistance switching used in arc interruption. **10**

Q 4 a) Explain motor protection against single phasing with neat diagram. **10**

Q 4 b) Explain TRV and RRRV. Derive an expression for restriking voltage. **10**

Q 5 a) Explain the different Earth Fault Schemes and its application. **10**

Q 5 b) Explain current grading and time grading relay system of protection of feeder. **10**

Q 6 a) Compare static relays with electromagnetic relays. **10**

Q 6 b) Draw and explain operation of Oil Circuit Breaker. **10**

(3 Hours) [Total Marks : 80

Question No 01 is compulsory.
Attempt any Three questions from the remaining questions.
Each question carries 20 marks.
Figure to the right indicates full marks.

Q. 1. Attempt **any 04** sub-questions out of 05 sub-questions.
I] Compare the microprocessor with microcontroller. (05 marks)
II] Describe the Access Bank concept used in Pic18 microcontroller. (05 marks)
III] Explain the GIE and PEIE bits with reference to interrupt. (05 marks)
IV] Describe the Program Counter (PC) and Table Pointer (TBLPTR) registers. (05 marks)
V] Explain the Timer0 Control Register (T0CON) used in Pic18. (05 marks)

Q. 2. A] What is mean by Addressing mode? Explain the addressing modes used in Pic18 microcontroller. (10 marks)
B] Explain the memory organization (Program and Data Memory) of Pic18 Microcontroller. (10 marks)

Q. 3. A] Explain the different instruction formats used in assembly level programming of Pic18 microcontroller. (10 marks)
B] Write a C program to flash an LED connected at RB1 at a frequency of 1KHz.Use Timer0 in 16-bit mode, Crystal oscillator frequency = 10MHz and prescaler of 64. (10 marks)

Q. 4. A] Describe the various special function registers used in USART module used in Pic18 microcontroller for serial communication. (10 marks)
B] Explain the inbuilt ADC module interfacing of Pic18 microcontroller. (10 marks)

Q. 5. A] Explain the Table Read operation along with the instructions associated with it.(10 marks)
B] Explain in brief, the Capture, Compare and PWM (CCP) module of Pic18. (10 marks)

Q. 6 Write any 02 short notes.
i] LCD interfacing with Pic 18 microcontroller. (10 marks)
ii] Seven Segment LED Interfacing with Pic 18 microcontroller. (10 marks)
iii] Stepper motor interfacing with Pic 18 microcontroller (10 marks)

Duration: 3 Hours **Marks: 80**

Note:
1. Q.no. 1 is compulsory.
2. Answer any three questions from Q. No. 2 to Q. No. 6.
3. Write in legible handwriting.
4. Make any suitable assumptions wherever required.
5. Must make suitable supporting diagrams wherever desired.
6. Figure to the right indicates marks.

Q1 Each question carries five marks 20

a. Draw the bode plot of a typical lag compensator. Why it is called as a lag compensator?

b. Where a pole should be placed on z-plane to drive the steady state error of a sampled system to zero?

c. Where is the region of stability on the z-plane? Compare that with the stability region in s-plane.

d. Under what conditions would you use an observer in your state space design? Which plant representation lends itself to easier design of an observer? Why?

Q2 a. Draw the implementation for the digital compensator defined by Gc(z)=$\frac{(z+0.5)}{z^2-0.5z+0.7}$ 05

b. Given the following open-loop plant: $G(s) = \frac{20(s+2)}{s(s+5)(s+7)}$ Design a controller to yield a 10% overshoot and a settling time of 2 seconds by assuming that the plant is represented in the parallel form. 15

Q3 a. Use frequency response methods to design a lead compensator for a unity feedback system where G(s)=$\frac{K(s+7)}{s(s+5)(s+15)}$ and the following specifications are to be met: percent overshoot=15%, Settling time=0.1sec, and Kv=1000. 10

b. Given the unity feedback system with G(s)=$\frac{K}{s(s+3)(s+9)}$ use frequency response methods to determine the value of gain K to yield a step response with a 15% overshoot. 10

Q4 a. Compare PI and Lag compensator to achieve the desired response, concerning to the pole zero locations and the transfer functions. Also develop the circuits for their realizations. 10

b. A unity feedback system with forward path transfer function G(s)= $\frac{K}{(s+1)(s+5)(s+8)}$ has 15% overshoot. Evaluate the current dominant poles using R.L and then design a PD controller to reduce the peak time by a factor of 2. 10

Q5 a. Design an integral controller to yield a 10% overshoot, 0.5 sec. settling time and zero steady state error for a step input for the following plant. 10

$$\dot{x} = \begin{bmatrix} -2 & 1 \\ 0 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \qquad y = [1 \quad 1]\, x$$

b. Consider the plant G(s) $= \frac{(s+2)}{(s+5)(s+6)(s+9)}$ which is represented in observer canonical form. Design an observer with a transient response described by ζ=0.6 and w_n=120. 10

Q6 a. Given a sampler and z.o.h. in cascade with G(s)= $\frac{K}{(s+5)}$ find the range of K to make the system stable. Sampling time T=0.1 second. 10

b. For the digital system with forward transfer function G(z)= $\frac{0.13(z+1)}{(z-1)(z-0.74)}$ find the static error constants and the steady state error if the inputs are u(t), t u(t) and $\frac{t^2}{2}u(t)$ for T=0.1 10

Duration – 3 Hours **Total Marks assigned to the paper- 80**

N.B.:- (1) Question No.**1** is compulsory.
(2) **Attempt** any **three** questions out of remaining **five** questions.
(3) Assume suitable data if necessary and justify the same.

Q 1. Answer the following questions. **20**
a) Define symmetric and anti-symmetric signals.
b) Summarize the properties of ROC.
c) Find the Fourier transform of $x(t) = e^{-2t} \cos 3t\, u(t)$.
d) List any three properties of DTFT.

Q 2 a) (i) Write about elementary Continuous time Signals in detail. **10**
(ii) Describe whether the following signal is periodic. If periodic determine the fundamental period.
$x(t) = 3\cos(4t) + 2\sin(\pi t)$

Q 2 b) Derive the odd and even components of the following signals. **10**
$x(t) = \sin(t) + 2\sin(t) + 2\sin 2(t)\cos(t)$
$x[n] = \{1, 0, -1, 2, 3\}$

Q 3 a) (i) Find out the Fourier transform of $x(t)=e^{-at}\, u(-t)$ **10**
(ii) Determine the Fourier series representation of the signal
$x(t) = 2+\cos(4t) + \sin(6t)$

Q 3 b) Formulate the trigonometric Fourier series over the interval (-1, 1) for the signal $x(t) = t^2$. **10**

Q 4 a) (i) Deduce the initial value of $X(z) = \frac{z+2}{(z+1)(z+2)}$ **10**

(ii) Evaluate the Z- transform of $x(n) = (2/3)^n\, u(n) + (-1/2)^n\, u(n)$.

Q 4 b) (i) Infer the Z-transform and ROC of $x[n] = 2^n\, u(n)+3^n\, u(-n-1)$. **10**
(ii) Determine the Z-transform of the sequence $x(n) = \{5,3,2,4\}$.

Q 5 a) Write short note on (i)properties of DFT (ii) Types of signals **10**

Q 5 b) Determine eight-point DFT of the following sequences using radix-2 DIT-FFT algorithm $x(n) = \{1, -1, -1, -1, 1, 1, 1, -1\}$. **10**

Q 6 a) Design a digital Butterworth filter satisfying the constraints using bilinear transformations. **10**
$0.707 \le |H(\omega)| \le 1.0;\ 0 \le \omega \le \pi/2$
$|H(\omega)| \le 0.2;\ 3\pi/4 \le \omega \le \pi.$

Q 6 b) Design an FIR filter for the ideal frequency response using Hamming window with N=7 **10**
$Hd(\omega) = \{e^{-j2\omega};\ -\pi/8 \le \omega \le \pi/8$
$0;$ otherwise.

Time: 3 Hours **Marks: 80**

Note:- 1. Question No. 1 is compulsory
2. Attempt any **three** questions out of remaining **five** questions
3. Assume suitable data if necessary & justify the same
4. Figures to the right indicates marks

Qu.1	Attempt **any four**.	**Marks**
(a)	Discuss advantages of Electric traction over other system of traction.	**[5]**
(b)	Draw speed time curve of urban and suburban services	**[5]**
(c)	How DC series motor is most suitable for traction? Discuss	**[5]**
(d)	Write a brief note on sectionalizing paralleling post	**[5]**
(e)	Write a note on Kando system	**[5]**
Qu.2 (a)	Draw trapezoidal type speed time curve and derive the expression for distance travelled.	**[10]**
(b)	Draw 132/25 KV traction substation layout and discuss its operation in detail	**[10]**
Qu.3 (a)	Discuss the operation of DC traction using chopper controlled drive	**[10]**
(b)	Explain booster transformer with return conductor in detail.	**[10]**
Qu.4 (a)	Discuss the protection provided for transformer & overhead lines in traction .	**[10]**
(b)	Define the Tractive efforts. Derive the expression for total tractive efforts	**[10]**
Qu.5 (a)	An electric train weighing 500 tonnes climbs up gradient with G =8 and with following speed time curve 1. Uniform acceleration of 2.5 kmphps for 60 sec 2. Constant speed for 5 min 3. Coasting for 3 min 4. Dynamic braking at 3 kmphps to rest Train resistance is 25 N/tonne, rotational inertia effect 10% and combined efficiency of transmission motor & power modulator is 80 %. Calculate the Specific energy consumption	**[10]**
(b)	Explain the operation of power and auxiliary circuits use in traction	**[10]**
Qu.6 (a)	Discuss the current collection techniques used in overhead and underground system	**[10]**
(b)	Write a short note on DC and AC Track circuits	**[10]**

****

(3 Hours) **[Total Marks: 80]**

N.B.

1. **Question No.1 is Compulsory**.
2. Answer any three out of remaining five questions.
3. Assume any suitable data wherever required but justified the same.
4. Illustrate answer with sketches wherever required.

Q 1	a)	Write a short note on: Solar Pond.	**(05)**
	b)	Explain the necessity of energy storage.	**(05)**
	c)	Explain different types of energy storage.	**(05)**
	d)	Write a short note on: E-mobility storage applications.	**(05)**
Q 2	a)	Write a short note on Supercapacitors.	**(10)**
	b)	Explain in detail about sensible heat storage.	**(10)**
Q 3	a)	Explain briefly about Compressed air energy storage (CAES).	**(10)**
	b)	Explain in detail about design considerations for sizing of different types of energy storage systems for various applications.	**(10)**
Q 4	a)	Write a short note on Superconducting magnetic energy storage (SMES).	**(10)**
	b)	Explain in briefly about latent heat storage.	**(10)**
Q 5	a)	Explain in detail about Pumped hydro storage system.	**(10)**
	b)	Write a short note on: Hybrid Energy storage systems.	**(10)**
Q 6	a)	Explain in brief: Future technology in energy storage as Electric vehicle.	**(10)**
	b)	Explain working principle of Rechargeable battery. Illustrate emerging trends in batteries.	**(10)**

(3 Hours) **Total Marks - 80**

N.B. : (1) Question **No 1** is **Compulsory**.
(2) Attempt any **three** questions out of the remaining **five**.
(3) All questions carry equal marks.
(4) Assume suitable **data,** if required and state it clearly.

Que. 1) Attempt any **four** of the following:- **(05-Marks each)** **[20]**

a) Explain Physical realization of compensator with passive and active components.
b) Explain the Transient response design using root locus technique.
c) Explain Effect of Phase Lag Compensation also explain advantages and disadvantages of Lag Compensation.
d) Explain Controller design by pole placement topology in phase variable form.
e) Given a point on the z-plane, how can one determine the associate settling time and peak time.
f) Write a short note on modeling of the sampler in digital control system.

Que. 2) **[20]**

a) A unity feedback system with the forward transfer function, $\boldsymbol{G(s) = \frac{K}{S(S+7)}}$ is operating with a closed-loop step response that has 15% overshoot. Do the following:
(i) Evaluate the settling time.
(ii) Design a lead compensator to decrease the settling time by three times. Choose the compensator's zero to be at -10. **[10]**

b) Given the system of Figure, Design a PID controller so that the system can operate with a peak time that is two-thirds that of the uncompensated system at 20% overshoot and with zero steady-state error for a step input. **[10]**

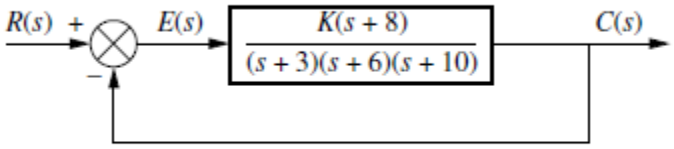


Figure: Uncompensated feedback control system

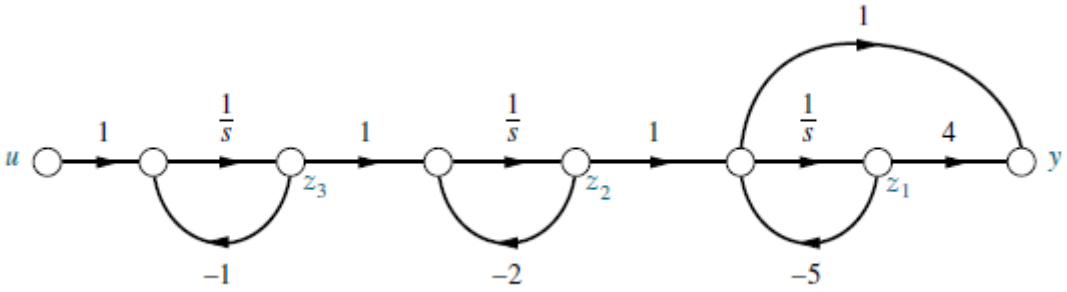
Que. 3) **[20]**

a) Use frequency response methods to design a lead compensator for a unity feedback system where, $\boldsymbol{(S) = \frac{K(S+7)}{S(S+5)(S+15)}}$ **,** and the following specification are to be met: percentage overshoot=15%, settling time=0.1 Sec. and $\boldsymbol{K_V = 1000}$ **.** **[10]**

b) Find the value of preamplifier gain K to yield a 9.5% overshoot in transient response for step input for the transfer function is, $\boldsymbol{G(S) = \frac{100K}{S(S+36)(S+100)}}$. **[10]**

Que. 4) **[20]**

a) Design a state-variable feedback controller to yield a 20.8% overshoot and a settling time of 4 seconds for a plant, $\boldsymbol{G(S)} = \frac{(S+4)}{(S+1)(S+2)(S+5)}$ that is represented in cascade form as shown in Figure, **[10]**

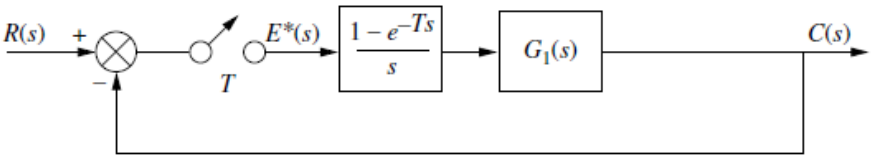


b) Design an integral controller to yield a 10% overshoot, 0.5 Sec. settling time and zero steady state error for a step input for the following plant. $\dot{\boldsymbol{X}} = \begin{bmatrix} -2 & 1 \\ 0 & -5 \end{bmatrix} \boldsymbol{X} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \boldsymbol{U}$; and $\boldsymbol{Y} = [1 \quad 1]\boldsymbol{X}$. **[10]**

Que. 5) **[20]**

a) Given a Z.O.H. in cascade with, $\boldsymbol{G(S)} = \frac{(S+2)}{(S+1)}$, find the sampled-data transfer function, G(z), if the sampling time, T, is 0.5 second. **[10]**

b) For step, ramp, and parabolic inputs, find the steady-state error for the feedback control system shown in following Figure, if, $G_1(\boldsymbol{S}) = \frac{20(S+3)}{(S+4)(S+5)}$, Let T = 0.1 second. **[10]**



Que. 6) **[20]**

a) Explain the Implementation of Digital Compensator, And also develop a flowchart for the digital compensator of given function, $\boldsymbol{G_C(Z)} = \frac{z+0.5}{z^2-0.5z+0.7}$. **[10]**

b) Explain in brief Cascade Compensation of digital system using s-plane. **[10]**
