College of Engineering, Pune

(M.Tech)- (Electrical) Power Systems

(EE)- (Electrical Machine Analysis)

Date- 29th Sept.2011 **Timing: 3 hrs**
Academic Year: 2011- 12 **Max. Marks: 100**

Autumn Semester

Instructions:

1. *Solve* ***Any FOUR*** *questions.*
2. *All questions carry equal marks.*
3. ***Open Book*** *Examination. You may use* ***any book*** *during examination.*

Q1

The developed diagram shown in Fig. 1.P-4 shows the arrangement of the stator windings of a 2-pole, 2-phase machine. Each coil side has n_c conductors, and i_{as} flows in the as winding and i_{bs} flows in the bs winding. Draw the air-gap MMF (a) due to i_{as}(MMF_{as}) and (b) due to i_{bs}(MMF_{bs}).

Assume that each coil side of the winding shown in Fig. 1.P-4 contains n_c conductors. The windings are to be described as sinusoidally distributed windings with N_p the maximum turns density and N_s the number of equivalent turns in each winding, which is a function of n_c. Express (a) N_{as} and N_{bs}, (b) MMF_{as} and MMF_{bs}, and (c) the total air-gap MMF (MMF_s) produced by the stator windings.

Consider the 2-phase stator windings described in Problem above, (a) With $I_{as} = \sqrt{2}I_s \cos[\omega_e t + \theta_{es}(0)]$ determine I_{bs} in order to obtain a constant amplitude MMF (MMF_s) which rotates clockwise around the air gap of the machine. Repeat (a) with (b) $I_{as} = -\sqrt{2}I_s \cos\omega_e t$, ($c$) $I_{as} = \sqrt{2}I_s \sin\omega_e t$, and ($d$)$I_{as} = -\sqrt{2}I_s \sin[\omega_e t + \theta_{es}(0)]$.

Q.2

An elementary 2-pole, 2-phase, salient-pole synchronous machine is shown in Fig. 1.P-6. The winding inductances may be expressed as

$$L_{asas} = L_{ls} + L_A - L_B \cos 2\theta_r$$

$$L_{bsbs} = L_s + L_A + L_B \cos 2\theta_r$$

$$L_{asbs} = -L_B \sin 2\theta_r$$

$$L_{fdfd} = L_{lfd} + L_{mfd}$$

$$L_{asfd} = L_{sfd} \sin \theta_r$$

$$L_{bsfd} = -L_{sfd} \cos \theta_r$$

Verify these relationships and give expressions for the coefficients L_A, L_B, L_{mfd}, and L_{sfd} similar in form to those given for a 3-phase machine. Modify these inductance relationships so that they will describe a 2-phase, uniform air-gap synchronous machine.

Write the voltage equations for the elementary 2-pole, 2-phase, salient-pole synchronous machine shown in Fig. 1.P-6 and derive the expression for $T_e(i_{as}, i_{bs}, i_{fd}, \theta_r)$.

A reluctance machine has no field winding on the rotor. Modify the inductance relationships given in above Problem [redacted] so as to describe the winding inductances of a 2-pole, 2-phase, reluctance machine. Write the voltage equations and derive an expression for $T_e(i_{as}, i_{bs}, \theta_r)$.

Q3

Assume the steady-state *abc* variables are of the form

$$F_{as} = \sqrt{2}F_a \cos \omega_e t$$

$$F_{bs} = \sqrt{2}F_b \cos\left(\omega_e t - \frac{2\pi}{3}\right)$$

$$F_{cs} = \sqrt{2}F_c \cos\left(\omega_e t + \frac{2\pi}{3}\right)$$

where F_a, F_b, and F_c are unequal constants. Show that this unbalanced set of *abc* variables forms 2-phase balanced sets of *qs* and *ds* variables in the arbitrary reference frame with the arguments of $(\omega_e t - \theta)$ and $(\omega_e t + \theta)$. Note the form of the *qs* and *ds* variables when $\omega = \omega_e$ and $\omega = -\omega_e$.

Repeat Problem [redacted] with

$$F_{as} = \sqrt{2}F_s \cos(\omega_e t + \phi_a)$$

$$F_{bs} = \sqrt{2}F_s \cos(\omega_e t + \phi_b)$$

$$F_{cs} = \sqrt{2}F_s \cos(\omega_e t + \phi_c)$$

where ϕ_a, ϕ_b, and ϕ_c are unequal constants.

Q.4

Consider the 2-phase induction machine shown in Fig. 1.P-8. $I_{as} = \sqrt{2}I_s \cos \omega_e t$ and $I_{bs} = -\sqrt{2}I_s \sin \omega_e t$. If the rotor windings are open-circuited, express V_{ar}.

Derive an expression for the torque between the *as* and *bs* windings of the 2-pole, 2-phase induction machine shown in Fig. 1.P-8 with all other windings open-circuited. Repeat for a 4-pole, 2-phase induction machine.

Assuming that this machine has 3 phase stator winding and 2 phase rotor as shown in the fig. 1.p.8, develop the equivalent circuits in arbitrary reference frame.

Q.5

A 2-pole, 2-phase, salient-pole synchronous machine is shown in Fig. 5.P-1. In the case of a 2-phase synchronous machine the magnetizing inductances are defined:

$$L_{mq} = L_A - L_B$$

$$L_{md} = L_A + L_B$$

Derive the voltage equation and expression for electromagnetic torque. Express all resistance and inductance matrices. Identify the terms associated with reluctance torque, damping torque and torque due to interactions of stator and field mmfs.

Derive Park Equations for this machine and then arrive at electromagnetic torque expression.

Q.6 -A

A 4-pole, 3-phase, salient-pole synchronous machine is supplied from a 440-V (rms) line-to-line, 60-Hz source. The machine is operated as a motor with the total input power of 40 kW at the terminals. The parameters are

$$r_s = 0.3\,\Omega \qquad L_{md} = 0.015\text{ H}$$

$$L_{ls} = 0.001\text{ H} \qquad L_{mq} = 0.008\text{ H}$$

Assume the positive direction of current is into the stator terminals.

(*a*) The excitation is adjusted so that $\tilde{I}_{as}$ lags $\tilde{V}_{as}$ by 30°. Calculate $\tilde{E}_a$ and the reactive power Q. Draw the phasor diagram.

(*b*) Repeat *a* with the excitation adjusted so that $\tilde{I}_{as}$ is in phase with $\tilde{V}_{as}$.

(*c*) Repeat *a* with the excitation adjusted so that $\tilde{I}_{as}$ leads $\tilde{V}_{as}$ by 30°.

Q.6 -B

A 2-pole, 220-V (rms) line-to-line, 5-hp, 3-phase reluctance machine has the following parameters

$$r_s = 1\,\Omega \qquad L_{md} = 0.10\,\text{H}$$

$$L_{ls} = 0.005\,\text{H} \qquad L_{mq} = 0.02\,\text{H}$$

The motor is supplied from a 60-Hz, 220-V source and it is operating at rated torque output. Calculate δ and $\tilde{I}_{as}$.

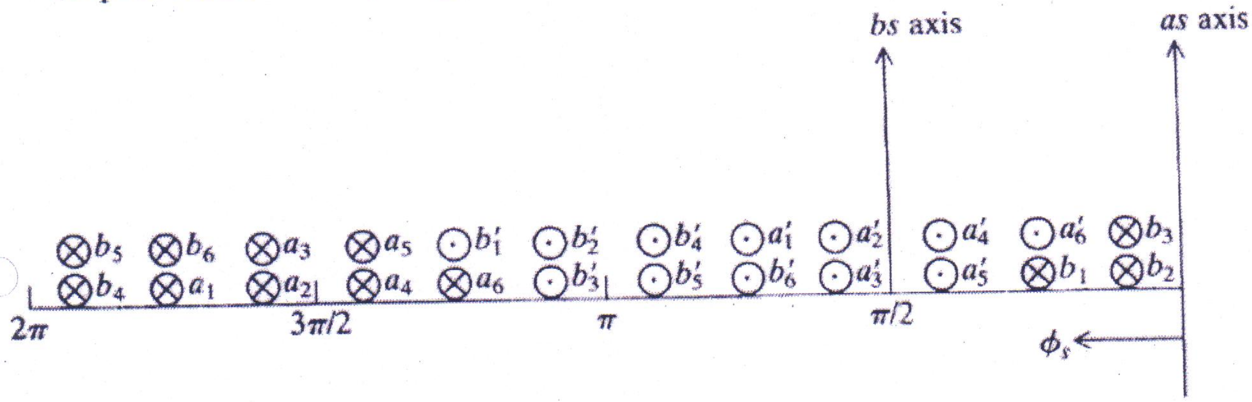

Figure 1.P-4 Stator winding arrangement of a 2-pole, 2-phase machine.

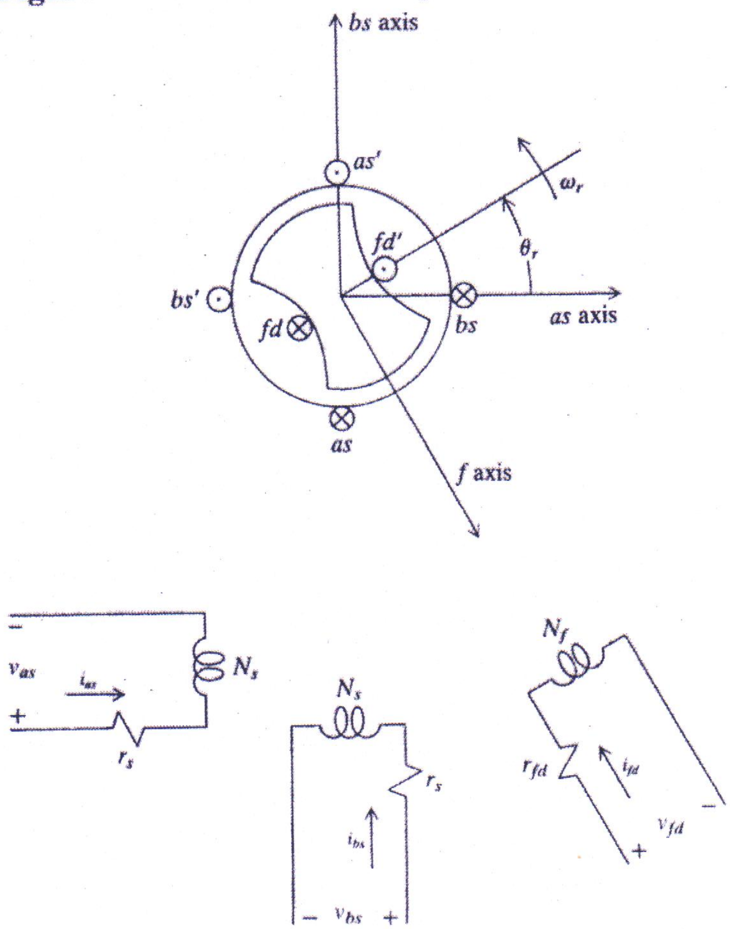

Figure 1.P-6 Elementary 2-pole, 2-phase, salient-pole synchronous machine.

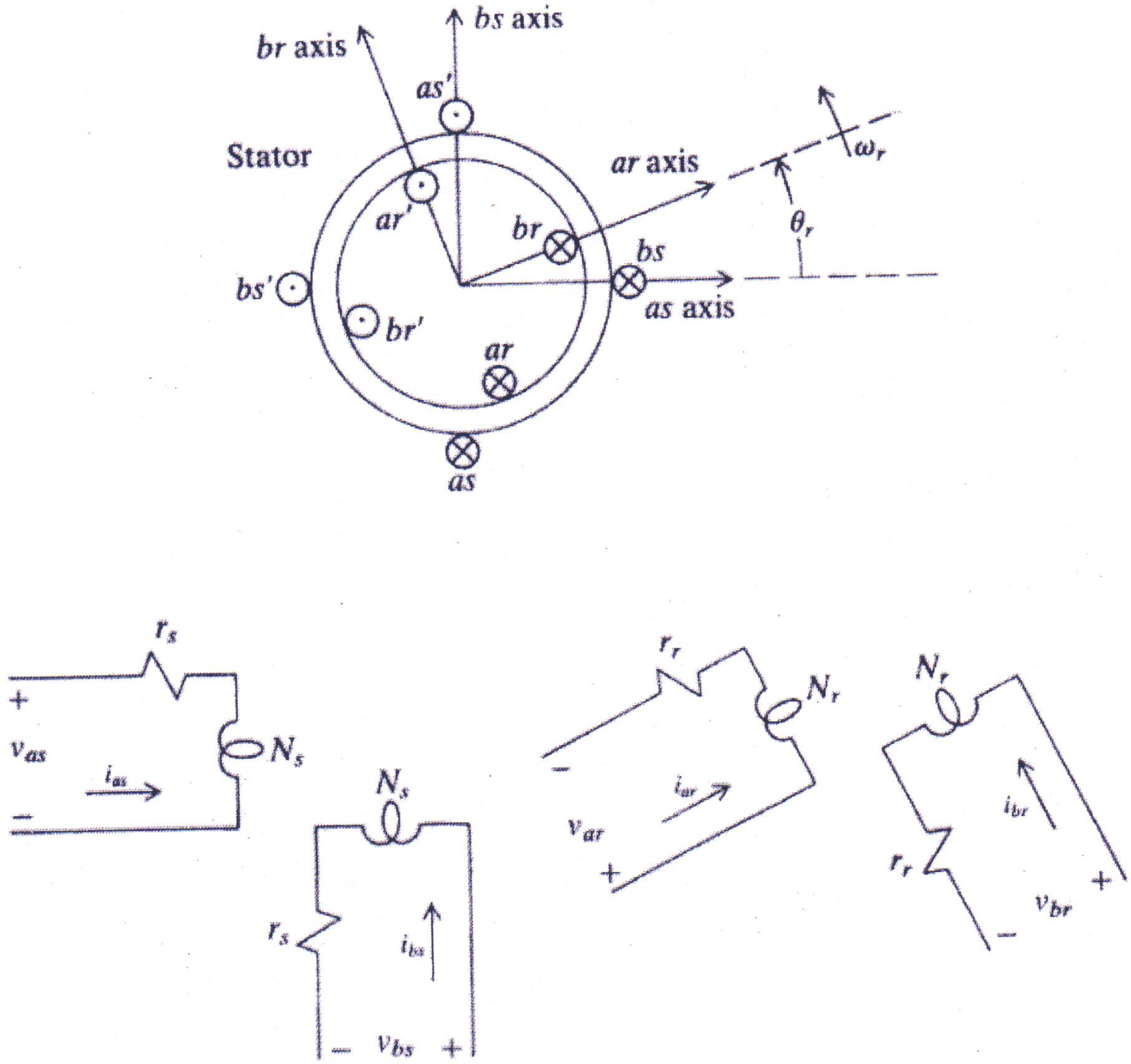

Figure 1.P-8 Elementary 2-pole, 2-phase symmetrical induction machine.

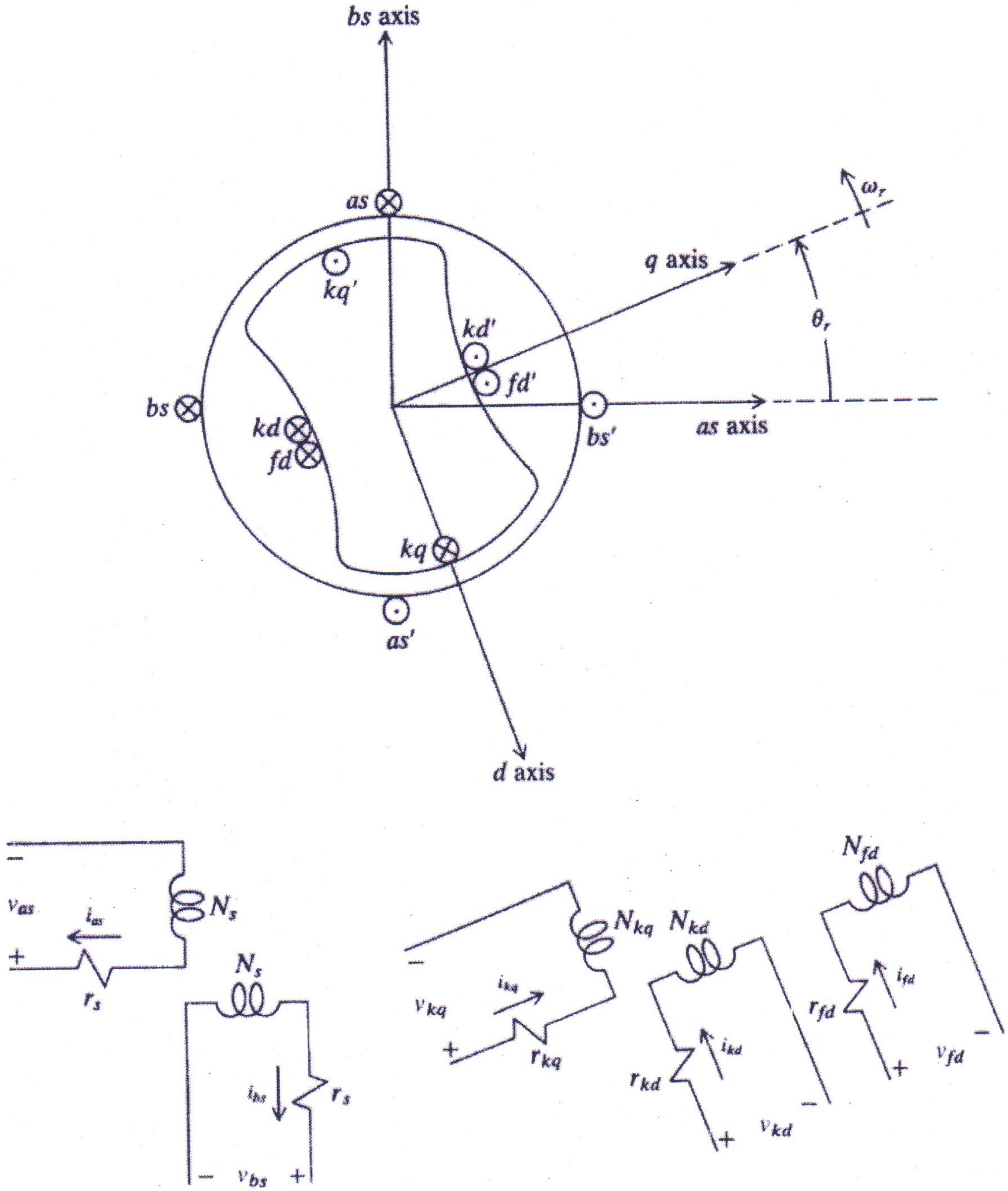

Figure 5.P-1 Two-pole, 2-phase, salient-pole synchronous machine.

College of Engineering, Pune

End Semester Exam –Nov. 2011

F.Y. M.Tech – Electrical (Power System)

EE 5101- Power System Analysis

Day & Date : Monday, 21st Nov. 2011 — Time: 4.00 to 7.00 pm

Maximum Marks: 50 — Duration: 3 Hrs

Instructions

1. All questions are compulsory.
2. All the symbols and notations carry their usual meaning unless otherwise stated.
3. Assume suitable data wherever necessary.

Q.1	(a)	What are the desirable qualities of a power flow algorithm? Give details.	5
	(b)	In a power system, voltage of a bus is to be automatically controlled and maintained constant by changing tap of OLTC transformer. The required change in tap is to be determined through NRLF. Explain the possible approaches to achieve the same.	5
Q.2	(a)	Why weights are assigned to the different measurements in power system state estimation? What is the criterion of deciding these weights? Explain.	6
	(b)	Bring out the salient points of difference between angle stability and voltage stability.	6
Q.3	(a)	Explain generalized algorithm for fault analysis.	7
	(b)	Define the following factors with reference to power system security: i) Line Outage Distribution Factor ii) Generation Shift Distribution Factor	3
Q.4		What are the approaches for contingency analysis from overload point of view? Explain the procedure of line outage simulation.	8
Q.5		A 25 MVA, 13.2 kV alternator with solidly grounded neutral has a subtransient reactance of 0.25 pu. The negative and zero sequence reactances are 0.35 and 0.1 pu. respectively. The alternator is unloaded. A double line-to-ground fault occurs at the terminals of the alternator. Determine the fault current and the line-to-line voltages at the fault.	10

ELECTRICAL ENGG. DEPT.
COLLEGE OF ENGINEERING , PUNE

End-sem Exam

EE5103: High Power Converters

Programme: M.Tech. (Electrical) Power and Control Systems
Year 2011-2012
Duration: 3 Hour — Date: 25/11/2011
Instructions: Solve any five questions. — Max. Marks: 50
Assume necessary data if required.

Qu. 1 a)	Determine the device switching pattern to obtain five levels at the output of three phase diode clamp multilevel inverter. Draw circuit diagram and explain the working principle. Define purpose of capacitor connected across dc input. Draw gating signals and output phase voltage waveform.	6
Qu. 1 b)	What are the advantages of cascaded H bridge with separate dc voltage inverter over diode clamped and flying capacitor multilevel inverter.	4
Qu.2	Draw twelve pulse line frequency converter arrangements with two Y-Y and Δ-Y transformer. Where transformer introduces a phase shift of 30 deg. in the current and voltage in the ac side. What order of harmonics will be eliminated with this transformer? Derive an expression for input line current.	10
Qu.3	Determine the switching time of each switch (S1 to S6), magnitude of reference vector and total number of switching per sample period of a 3 phase full bridge inverter when operated with SVPWM technique. The reference vector Vr is in the sector-II . The modulation index Ma=0.8, the dc voltage Vd=100V, switching frequency f_{sw}=900Hz, fundamental output frequency f_1=60Hz. Draw the switching pattern to optimize switching losses.	10
Qu. 4	What is difference between PWM CSI and load commutated CSI? Explain the trapezoidal modulation technique for PWMCSI . Draw gate signal waveform for each switch. What conditions should be satisfied by the switching pattern for CSI? What is the order of dominant harmonics obtained with this modulation technique?	10
Qu.5 a)	The buck converter has an input voltage of 10V, switching frequency of 1kHz. The load requires an average voltage of 5V with a maximum ripple voltage of 20mV. The maximum ripple current of the output inductor is 0.2A. Determine the duty ratio, the output inductance and output capacitance.	5

Qu.5	b)	Explain the two modes of operation of Cuk converter with neat ckt. Diagram. Derive the expression for voltage across boost capacitor and duty ratio.	5
Qu. 6	a)	A three phase full bridge inverter uses multiple bipolar notches and it is required to eliminate fifth, seventh and eleventh harmonics from the output waveform. Determine the number of notches and equations to find their angles.	5
Qu. 6	b)	Consider a square wave inverter with Vdc=100V, R=10 Ohms, L=25mH, f=60Hz. Determine the fundamental output voltage, THD for output voltage and current and power absorbed by the load.	5

!!Best luck!!

DEPARTMENT OF ELECTRICAL ENGINEERING
COLLEGE OF ENGINEERING, PUNE-05

FY.M.TECH-ELECTRICAL-POWER SYSTEM

SUBJECT:- ENGINEERING OPTIMIZATION(EE 5211)

Max. Marks.:-50

Date:-27/11/2011
Time:-4.00 pm to 7.00 pm

Instructions:-

1. Solve any **five** questions.
2. Assume suitable data wherever necessary
3. Non programmable calculators are allowed.

Q 1. (a) Determine the optimum BFS to the following Transportation problem, Use Vogel's approximation method to find IBFS. **6**

10	9	8	8
10	7	10	7
11	9	7	9
12	14	10	4
10	10	8	28

(b) A company has two grades of inspectors grade I and II, who are to be assigned for a quality control inspection. It is required that at least 1800 pieces be inspected per 8 hrs a day. Grade I inspector can check pieces at the rate of 25 per hr, with accuracy of 98%. Grade II inspector can check pieces at the rate of 15 per hr, with accuracy of 95%. **4**

The wage rate of grade I inspector is Rs. 4 per hr while that of grade II inspector is Rs. 3. Each time an error is made by an inspector, the cost to the company is Rs 2. The number of available inspectors of grade I and grade II is limited to 8 and 10 respectively.

The company wants to determine the optimal daily assignments of inspectors which will minimize total cost of inspection. Formulate the linear programming problem.

Q 2. (a) Minimize the function given below in the interval [0 5] by Fibonacci method. Consider n=3. **5**

$$f(x) = x^2 + \frac{54}{x}$$

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(b) Solve the following Linear Programming problem by Simplex method. 5

$$\text{maximize } f = 15x_1 + 6x_2 + 9x_3 + 2x_4$$

$$\begin{aligned} \text{Subject to } \quad & 2x_1 + x_2 + 5x_3 + 6x_4 \le 20 \\ & 3x_1 + x_2 + 3x_3 + 25x_4 \le 24 \\ & 7x_1 + x_2 \le 70 \\ & x_1, x_2, x_3, x_4 \ge 0 \end{aligned}$$

Q 3. Answer any **two** of the following.

(a) Minimize the function $f = 2x_1^2 + x_2^2$ starting from the point $X_1 = \begin{pmatrix}1\\2\end{pmatrix}$ using the Steepest Descent method. Perform two iterations. $\epsilon = 0.01$ 5

(b) Minimize $f = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ from the starting point $\begin{pmatrix}0\\0\end{pmatrix}$ using the Univariate method. (Two iterations only.) $\epsilon = 0.01$ 5

(c) Write algorithm for 'Quadratic interpolation method' of nonlinear one dimensional minimization problem. 5

Q 4. (a) Minimize the function $f = +4x_1^2 + 3x_2^2 - 5x_1x_2 - 8x_1$ starting from the point $X_1 = \begin{pmatrix}0\\0\end{pmatrix}$ using Powell's method. Perform one complete cycle of univariate and pattern search. Take probe length = 0.01 5

(b) Maximize $f(x) = 2x_1 + x_2 + 10$ subject to $g(x) = x_1 + 2x_2^2 - 3$ using Lagrange multiplier method. 5

Q 5. Write algorithm for following methods.

(a) Sequential Linear Programming method for constrained nonlinear optimization problem. 5

(b) Newton method for one dimensional nonlinear optimization problem. 5

Q 6. (a) Solve the following problem by 'Interior Penalty method'. 5

Minimize $f(X) = (x_1 + 2)^3 + 3x_2 + 1$

Subject to $g_1(X) = 2 - x_1 \le 0$

$g_2(X) = -x_2 \le 0$

Take $r_1 = 10$ and $c = 0.01$. Perform three iterations.

(b) Explain the concept of suboptimization. State and explain the Bellman's Principle of optimality. 5

---------------X------------------X------------------X-------------