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06ME71

Seventh Semester B.E. Degree Examination, December 2011

Control Engineering

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define control system. Compare open loop and closed loop control systems with two examples for each type. **(06 Marks)**

b. Name the basic controllers and their good and undesirable characteristics. **(06 Marks)**

c. With a block diagram, explain proportional, integral differential controller. **(08 Marks)**

2 a. Obtain the transfer function of the mechanical system shown in Fig.Q2(a), writing the physical system equations. **(08 Marks)**

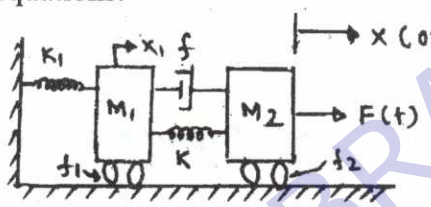

Fig.Q2(a)

b. Write the differential equations governing the behaviour of the mechanical system shown in Fig.Q2(b). Also obtain the analogous electrical circuit based on force voltage analogy and loop equations. **(12 Marks)**

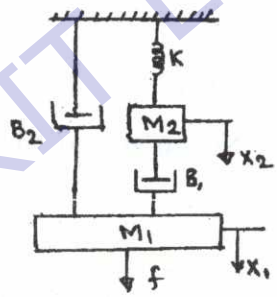

Fig.Q2(b)

3 a. Determine the overall transfer function of the block diagram shown in Fig.Q3(a). **(10 Marks)**

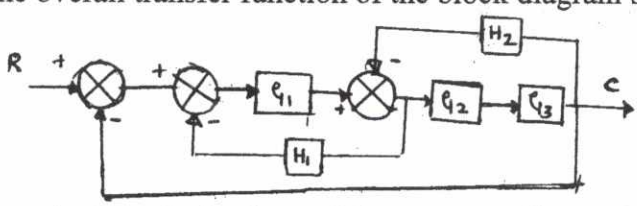

Fig.Q3(a)

b. Use Mason's gain formula for determining the overall transfer function of the system shown in Fig.Q3(b). **(10 Marks)**

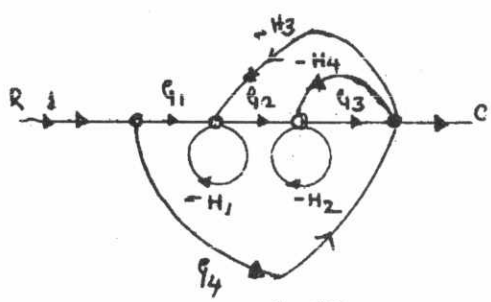

Fig.Q3(b)

4 a. Derive an expression for the unit step response of first order systems and steady state error. **(08 Marks)**

b. A unity feedback system is characterized by an open-loop transfer function $G(S) = \frac{K}{S(S+10)}$.

Determine the gain K, so that, the system will have a damping ratio of 0.5. For this value of K, determine the settling time, peak overshot and time to peak overshot for a unit step input. **(08 Marks)**

c. Determine the stability of the system whose characteristic equation is given by $S^4 + 6S^3 + 23S^2 + 40S + 50 = 0$ **(04 Marks)**

PART – B

5 a. State and explain the Nyquist stability criterion. **(06 Marks)**

b. Draw the Nyquist plot for a given open loop transfer function $GH(S) = \frac{K}{S(1+S)(1+2S)(1+3S)}$. Determine the range of K for which the system is stable. **(14 Marks)**

6 a. Define the terms gain margin and phase margin. Explain how these can be determined from Bode plots. **(06 Marks)**

b. Sketch the Bode plot for the transfer function $G(S) = \frac{Ke^{-0.1S}}{S(1+S)(1+0.1S)}$. Find the value of K for the crossover frequency = 5 rad/sec. **(14 Marks)**

7 An aeroplane with an autopilot in the longitudinal mode has a simplified openloop transfer function $G(S)H(S) = \frac{K(S+1)}{S(S-1)(S^2+4S+16)}$. Sketch the root-locus plot and determine the range of K for stability. **(20 Marks)**

8 a. Discuss various methods of compensation in feedback control systems. **(10 Marks)**

b. Explain with a block diagram the lag lead compensator. **(10 Marks)**

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06ME72

Seventh Semester B.E. Degree Examination, December 2011

Computer Integrated Manufacturing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain different types of automation. **(06 Marks)**

b. Define the terms : i) Production capacity, ii) Manufacturing lead time, iii) Utilization. Write a mathematical equation for each. **(06 Marks)**

c. In a manufacturing plant, a part is produced in a batch size of 60 units. The batch must be routed through eight operations to complete it. Average setup time is 5 hr/operation and average operation time is 10 min. Average non operation time is 7 hours/operation. Determine :

i) Manufacturing lead time in number of days, if the plant runs one 8 hr shift/day.

ii) Production rate of the plant. **(08 Marks)**

2 a. What are the symbols used in an automated flow line? **(05 Marks)**

b. What are the reasons for implementing storage buffers in an automated production line? **(05 Marks)**

c. Sketch and explain the following work part transfer mechanisms :

i) Linear walking beam ii) Geneva wheel. **(10 Marks)**

3 a. Give the reasons for the downtime, on an automated production line. **(08 Marks)**

b. Discuss the limits of storage buffer effectiveness. **(06 Marks)**

c. A 22-station in-line transfer machine has an ideal cycle time of 0.55 min. the probability of station breakdown is p = 0.01. Average downtime = 8.0 min. per line stop. Use the upper bound approach and determine :

i) Ideal production rate ii) Frequency of line stops

iii) Average actual production rate iv) Line efficiency. **(06 Marks)**

4 a. Explain the reasons for partially automating the production line. **(04 Marks)**

b. Write a note on computerized line balancing. **(04 Marks)**

c. The table below shows the precedence relationships and element time for a new part. Ideal cycle time is 10 seconds. Construct the precedence diagram, using Kilbridge and Wester method. Compute the balance delay and line efficiency. **(12 Marks)**

Element Number	Predecessor element	Time (seconds)
1	-	5
2	1	3
3	2	4
4	1	3
5	4	6
6	3, 5	5

Element Number	Predecessor element	Time (seconds)
7	6	2
8	7	6
9	6	1
10	6	4
11	10	4
12	8, 9, 11	7

PART – B

5 a. Discuss the principles used in product design to facilitate automated assembly. **(10 Marks)**

b. Sketch any three escapement and placement devices. **(05 Marks)**

c. Explain the applications of AGV. **(05 Marks)**

6 a. With the help of a block diagram, explain retrieval CAPP systems. **(10 Marks)**

b. Describe inputs to the MRP system. **(10 Marks)**

7 a. Distinguish between machining centre and turning centre. Also mention their classification. **(05 Marks)**

b. The top view of a component is shown in Fig.Q7(b). Write a complete part program to mill the profile of the part. Part thickness is 15 mm and cutter diameter is 10 mm. Clearly show the target point of the tool and axes on the sketch of the part. Target point is (30, 30, 30) from left top corner of the part. Assume suitable data. **(15 Marks)**

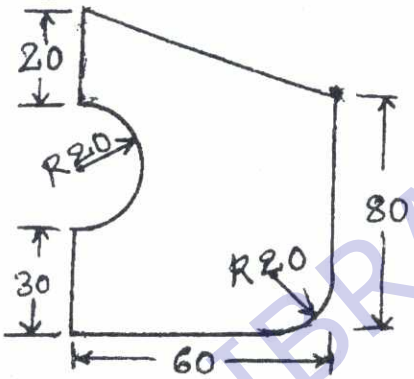

Fig.Q7(b)

8 a. With neat sketches, describe the geometrical configuration of a robot. **(12 Marks)**

b. Write a program for pick and place operation of a robot using VAL. Pick an object from the table and place it on the conveyor. Approach distance for the object on the table is 50 mm. Depart distance = 80 mm. Approach distance for the conveyor = 100 mm. Depart distance = 40 mm. Show the end effecter path. **(08 Marks)**

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06ME73

Seventh Semester B.E. Degree Examination, December 2011
Manufacturing Processes - III

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State the advantages and limitations of metal working processes. **(05 Marks)**

b. What is flow stress? Name the methods to determine the flow stress. Explain any one method. **(07 Marks)**

c. Explain Tresca and Von-Mises yield criterion. **(08 Marks)**

2 a. Discuss the factors affecting recrystallization temperature in hot working. State the advantages of hot working over cold working. **(08 Marks)**

b. Define formability of materials. Discuss any one method to determine formability. **(07 Marks)**

c. What is hydrostatic pressure in metal working? Explain. **(05 Marks)**

3 a. Discuss the following in forging process :
i) Friction hill ii) Forging defects iii) Material flow lines **(08 Marks)**

b. An aluminum billet 25 mm ϕ, 50 mm high is compressed between flat parallel dies to a height of 25 mm. The average yield stress is 6 N/mm^2. Find the frictionless work done. Also determine the maximum pressure exerted if the coefficient of sliding friction is 0.24. **(07 Marks)**

c. Explain die design parameters in forging. **(05 Marks)**

4 a. Discuss the effect of front and back tension in rolling. **(05 Marks)**

b. Explain the following rolling mills :
i) Two high mill ii) Cluster mill iii) Tandem mill **(08 Marks)**

c. Calculate the rolling load if steel sheet is hot rolled 30% from a 40 mm thick slab using a 900 mm diameter roll. The slab is 760 mm wide. Assume $\mu = 0.30$. The plane-strain flow stress is 140 MPa at entrance and 200 MPa at the exit from the roll gap due to the increasing velocity. **(07 Marks)**

PART – B

5 a. What is drawing process? Explain. **(05 Marks)**

b. What is redundant work in drawing? How is it estimated? **(07 Marks)**

c. Determine the drawing stress to produce a 20% reduction in a 10 mm stainless steel wire. The flow stress is given by $\sigma_0 = 1300\,\varepsilon^{0.30}$ MPa. The die angle is 12° and $\mu = 0.09$. If the wire is moving through the die at 3 m/s, determine the power required to produce the deformation. **(08 Marks)**

6 a. What is impact extrusion? Discuss. **(05 Marks)**

b. How seamless pipes are produced in extrusion process? Explain. **(07 Marks)**

c. Discuss any four extrusion defects with their causes and remedies. **(08 Marks)**

7 a. Explain combination die and progressive die in sheet metal forming. **(08 Marks)**

b. Discuss the following processes in sheet metal forming :
i) Roll bending ii) Blanking iii) Embossing iv) Deep drawing. **(08 Marks)**

c. Write a note on die and punch material in sheet metal forming. **(04 Marks)**

8 a. Discuss the principle and applications of electro hydraulic forming. **(08 Marks)**

b. Discuss the basic steps in the powder metallurgy process. **(07 Marks)**

c. Explain the atomization method of powder production in powder metallurgy. **(05 Marks)**

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06ME74

Seventh Semester B.E. Degree Examination, December 2011
Operations Research

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define operations research and discuss its scope. **(05 Marks)**

b. Old machines can be bought at Rs. 2 lakhs each and new machines at Rs.5 lakhs each. The old machines produce 3 components / week, while new machines produce 5 components / week, each component being worth Rs.30000. A machine (new or old) costs Rs.1 lakh /week to maintain. The company has only Rs.80 lakhs to spend on the machines. How many of each kind should the company buy to get a profit of more than Rs.6 lakhs/week? Assume that the company cannot house more than 20 machines. Formulate the problem and solve it graphically. **(15 Marks)**

2 a. Explain the concept the degeneracy in the simplex method. **(05 Marks)**

b. Solve the following LPP by BIG-M-Method:

Minimize $z = -8x_2$,

Subjected to the constraints $x_1 - x_2 \geq 0$

$2x_1 + 3x_2 \leq -6$

and x_1, x_2 are unrestricted. **(15 Marks)**

3 a. Explain clearly unbalanced transportation and degenerate transportation problems. **(05 Marks)**

b. A company has four factories F_1, F_2, F_3 and F_4 manufacturing the same product. Production and raw material costs differ from factory to factory and are given in the following table in the first two rows. The transportation costs from the factories to sales depots S_1, S_2, S_3 are also given. The last two columns in the table give the sales price and the toal requirement at the each depot. The production capacity of each factory is given in the last row.

		F_1	F_2	F_3	F_4	Sales price/unit	Requirement
Production cost/unit		15	18	14	13		
Raw material cost/unit		10	9	12	9		
Transportation cost/unit	S_1	3	9	5	4	34	80
	S_2	1	7	4	5	32	120
	S_3	5	8	3	6	31	150
Availability		10	150	50	100		

Determine the most profitable production and distribution schedule and the corresponding profit. The surplus production should be taken to yield zero profit. **(15 Marks)**

4 a. Solve the traveling salesman problem given by the following data:
$C_{12} = 20$, $C_{13} = 4$, $C_{14} = 10$, $C_{23} = 5$, $C_{34} = 6$, $C_{25} = 10$, $C_{35} = 6$, $C_{45} = 20$ where $C_{ij} = C_{ji}$. There is no route between cities i and j, if the value for C_{ij} is not shown. **(10 Marks)**

b. A ready made garment manufacturer has to process seven items through two stages of production, viz, cutting and sewing. The time taken for each of these items at the different stages is given below in appropriate units.

Item No.	1	2	3	4	5	6	7
Processing time Cutting	5	7	3	4	6	7	12
Processing time Sewing	2	6	7	5	9	5	8

i) Find an order in which these items are to be processed through these stages so as to minimize the total processing time.

ii) Suppose the third stage of production is added viz, pressing and packing with processing time for these items as follows:

Q.No.4 (b) Contd…

Item:	1	2	3	4	5	6	7
Processing time (Pressing and Packing):	10	12	11	13	12	10	11

Minimize the time taken to process all the items through all the three stages. **(10 Marks)**

PART – B

5 a. Describe the characteristics of queuing systems. **(05 Marks)**

b. In a railway yard, goods trains arrive at a rate of 30 trains per day. Assume that the inter arrival time follows an exponential distribution and the service time distribution is also exponential with an average 36 minutes. Calculate the following:

i) The average number of trains in the system.
ii) The probability that the queue size exceed 10.
iii) Expected waiting time in the queue.
iv) Average number of trains in the queue.
v) The changes in (I) and (II) if the input of trains increases to an average 33 per day.

(15 Marks)

6 a. Explain the basic steps in PERT / CPM techniques. **(05 Marks)**

b. A project consists of a series of tasks labeled A, B, …..H, I with the following relationships (W<XY means X and Y can not float until W is completed). With this notation, construct the network diagram having the following constraints:

A < D, E; B, D < F; C < G; G < H; F, G < I

Find also the minimum time of completion of the project when the time (in days) of completion of each task is as follows:

Task:	A	B	C	D	E	F	G	H	I
Time:	23	8	20	16	24	18	19	4	10

Further determine ES,EF, LS, LF and TF, FF, Interference and Independent float. **(15 Marks)**

7 a. Explain the characteristics of game theory. **(05 Marks)**

b. Use the dominance rule to reduce the following game to either $z \times n$ or $m \times z$ game and then solve it graphically. **(15 Marks)**

		Player B			
		B_1	B_2	B_3	B_4
Player A	A_1	19	6	7	5
	A_2	7	3	14	6
	A_3	12	8	18	4
	A_4	8	7	13	-1

8 a. What is an integer linear programming problem? How does the optimal solution of integer programming problem compares with that of linear programming problem? **(05 Marks)**

b. Use branch-and-bound technique to solve the following integer programming problem:

Maximize $z = x_1 + 2x_2$

Subject to constraints: $2x_2 \leq 7$

$x_1 + x_2 \leq 7$

$2x_1 \leq 11$

$x_1 \geq 0, x_2 \geq 0$ and x_1, x_2 are integers. **(15 Marks)**

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06ME754

Seventh Semester B.E. Degree Examination, December 2011
Solar Energy

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Use of charts and heat transfer databook is permitted.

PART – A

1 a. What is meant by a renewable energy source? Explain in brief, these energy sources, with special reference to Indian context. **(08 Marks)**

b. Write short notes on: i) The Sun ii) Solar spectrum iii) Spectral solar impedance. **(12 Marks)**

2 a. Sketch and explain the working of Pyranameter and sunshine recorder. **(14 Marks)**

b. Define beam, diffuse and solar insolation. **(06 Marks)**

3 a. Define the following :
i) Latitude at a place ii) Declination angle iii) Hour angle
iv) Solar altitude angle v) Zenith angle vi) Solar azimuth angle. **(12 Marks)**

b. Determine the value of solar radiation (H_{av}) over a horizontal surface for June 22, at the latitude of 10°N, if a = 0.3, b = 0.51 and $\frac{\bar{n}}{N} = 0.55$. Given (I_{SC} = 1353 W/m^2). **(08 Marks)**

4 a. Sketch and explain the parabolic collector. **(10 Marks)**

b. What are the various power generation methods? Sketch and explain the solar pond. **(10 Marks)**

PART – B

5 a. Explain with a neat diagram, the working of a solar cell. **(10 Marks)**

b. What are the applications of a solar photovoltaic system? **(10 Marks)**

6 a. Write the energy balance equation. Explain all the terms in it. **(04 Marks)**

b. What are the different types of losses that occur in flat plate collector? Explain briefly. **(04 Marks)**

c. Data for a flat plate collector used for heating a building are given below:

	Factors	Specifications
i)	Location and latitude	Baroda, 22°N
ii)	Data and time	January 1, 11.30-12.30
iii)	Annual average intensity of solar radiation	0.5cal/cm^{2}min
iv)	Collector tilt	37°N (Latitude +15°)
v)	Numbers of glass cover	2
vi)	Heat removal factor for collector	0.810
vii)	Transmittance of the glass	0.88
viii)	Absorptance of the plate	0.90
ix)	Top loss co-efficient for collector	6.80 kcal/hr m^2°C
x)	Collector fluid temperature	60°C
xi)	Ambient temperature	15°C
xii)	Diffused reflectance for glass cover	0.24

Calculate: I) Solar altitude angle II) Incident angle III) Collector efficiency **(12 Marks)**

7 a. Write short notes on: i) Number of covers ii) Selective surface iii) Intercept factor. **(06 Marks)**

b. Explain the effect of various parameters affecting the performance of the flat plate collector. **(14 Marks)**

8 a. Sketch and explain the cylindrical parabolic concentrator. **(10 Marks)**

b. Explain the orientation of concentration collectors and the various tracking modes, in detail. **(10 Marks)**

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06ME758

Seventh Semester B.E. Degree Examination, December 2011
Total Quality Management

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the TQM. Explain the six basic concepts of TQM. **(08 Marks)**
b. Sketch the TQM framework. **(04 Marks)**
c. List the dimensions of quality. Explain its meaning. **(08 Marks)**

2 a. Explain the contributions of the quality gurus. **(08 Marks)**
b. Sketch the Juran's trilogy. **(04 Marks)**
c. List the Deming's 14 points and explain any one. **(08 Marks)**

3 a. Explain the characteristics of quality leaders. **(08 Marks)**
b. Mention the quality statement, with the respect to an educational institution. **(04 Marks)**
c. Write short notes on: i) Prevention cost ii) Appraisal costs. **(08 Marks)**

4 a. Write short notes on: i) 7 QC tools ii) PDCA cycle. **(10 Marks)**
b. Sketch and explain the WV model, which shows the problem solving between level of thought and the level of experience. **(10 Marks)**

PART – B

5 a. Write short notes on: i) Six sigma ii) 5S. **(06 Marks)**
b. Define the bench marking. What are the six steps involved in bench marking process? **(08 Marks)**
c. Explain: i) 3M ii) Poka Yoke. **(06 Marks)**

6 a. Define the QFD. With a neat sketch, explain the four phases of QFD process. **(08 Marks)**
b. With the help of a simple form, explain the design FMEA document. **(08 Marks)**
c. List the two benefits of the QFD and FMEA. **(04 Marks)**

7 a. Write short notes on: i) ISO – 9000 series of standard ii) ISO – 14001 – requirements. **(10 Marks)**
b. With a neat sketch, explain the environmental management system model. **(10 Marks)**

8 Explain:
a. Flow chart for single sampling plan
b. Producer risk
c. Consumer risk
d. O C curve. **(20 Marks)**

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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06ME762

Seventh Semester B.E. Degree Examination, December 2011
Engineering System Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define the process of deigning. Describe the scope of a design process and elaborate on the design methods. **(10 Marks)**

b. Describe 'MORPHOLOGY' of design, with a flowchart. **(10 Marks)**

2 a. What rules should be followed in writing the 'preliminary need statement' to a design problem? Illustrate applying these rules, with a suitable example. **(10 Marks)**

b. With an example, describe how to arrive at the final 'specifications' for a design. **(10 Marks)**

3 a. Write a general checklist for an engineering design problem. What are the uses of this checklist? **(10 Marks)**

b. Explain the 'morphological analysis' technique, with a product design example. **(10 Marks)**

4 a. Explain the mathematical modeling for functional design. State its advantages. **(08 Marks)**

b. Explain 'sensitivity analysis'. If the cost C of producing a product in batch runs is dependent on parameters K_1, K_2, K_3 and Q describe by the equation :

$C = 2\sqrt{K_1 K_2 Q} + K_3 Q$, how do you calculate the relative sensitivity of C, with respect to a chosen parameter? **(08 Marks)**

c. Explain 'stability analysis', in design. **(04 Marks)**

PART – B

5 a. Draw the design tree for evaluating physical relisability of a conceived design. Illustrate calculating the chance of success. **(10 Marks)**

b. Explain the concept of utility scale. **(10 Marks)**

6 a. With respect to reliability law, draw the bath tub curve and explain it. **(06 Marks)**

b. Explain the terms : MTTF, MTBF. **(04 Marks)**

c. A complex engineering design can be described by a reliability block diagram, as shown in Fig. Q6(c).

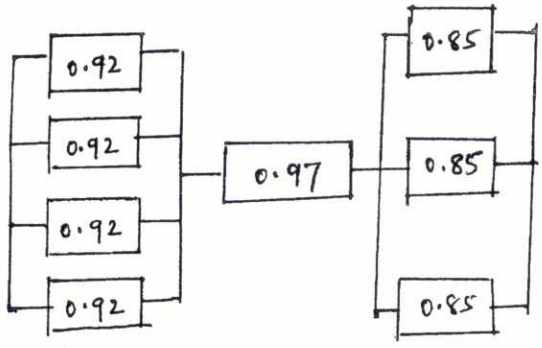

Fig. Q6(c)

In subsystem A, two components must operate for the subsystem to function successfully. Subsystem C has true parallel reliability. Calculate the reliability of each subsystem and the overall system reliability. **(10 Marks)**

7 a. M/s MGM Ltd. Manufactures maize starch and other related products at its Machche plant. Total plant capacity per year is 16,000 tonnes, of maize. Fixed costs are ₹ 481.9 lakh and variable costs are ₹ 30 lakhs per percentage of plant capacity utilization. Table Fig Q7(a) below gives the information on percentage recovery and sales values of all the products manufactured.

Table Q7(a), percentage recovery and rates of maize products.

Product	Percent recovery	Rate / tonne ₹
Starch	63	32,000
Maize oil	2.5	70,000
Oil cake	3.5	10,000
Maize gluten	10	8,000
Maize bran	11	4,500
Steep concentrate	6	8,000
(losses : 4 percent)		

Calculate the 'breakeven' capacity utilization for the plant. **(12 Marks)**

b. Table Q7(b), below gives the constraints on the availability of the four resources and the requirements per desk or chair, for a furniture shop manufacturing desks and chairs. The profit per desk is ₹ 30 and per chair is ₹ 20. Write the linear programming problem to maximize the profit of the furniture shop. Draw graphs to illustrate the meaning of constraints.

Table Q7(b), resources required for desks and chairs.

Resources	Availability	Requirements	
		Per desk	Per chair
Carpentry (man – hours)	200	8	4
Upholstery (man – hours)	120	–	3
Wood (m^3)	17	0.5	0.4
Laminate (m^2)	20	1	–

(08 Marks)

8 a. Draw the man –machine interaction cycle and explain the same. **(08 Marks)**

b. What is the guiding principle in the design of displays? Illustrate. **(06 Marks)**

c. Write explanatory note on design of controls. **(06 Marks)**

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06ME763

Seventh Semester B.E. Degree Examination, December 2011
Internal Combustion Engines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is chemical equilibrium? How does it affect the performance of an engine? **(06 Marks)**

b. With the help of a P-V diagram, explain how the variation in specific heats and dissociation of gases tend to deviate the ideal processes. **(10 Marks)**

c. What are the combustion charts? Where these are used and why? **(04 Marks)**

2 a. Briefly explain the mixture requirements of an SI engine. **(05 Marks)**

b. Explain the working of a simple carburetor with a sketch and give its limitations. **(08 Marks)**

c. Briefly explain the effect of various engine operating variables on SI engine knocking. **(07 Marks)**

3 a. Explain briefly, with pressure-crank angle diagram, the stages of combustion in CI engines. **(10 Marks)**

b. What are the different methods of controlling diesel knock? **(06 Marks)**

c. What is knock rating of diesel fuel? **(04 Marks)**

4 a. What are the basic requirements of a good SI engine combustion chamber? **(05 Marks)**

b. Explain with neat sketches, the F-head and I-head combustion chambers. Discuss their advantages and disadvantages. **(10 Marks)**

c. Explain the role of swirl in diesel engines. **(05 Marks)**

PART – B

5 a. Give the general chemical formula, molecular arrangement and mention whether saturated or unsaturated, the following constituents of crude petroleum:
i) Paraffin ii) Napthane iii) Olefin iv) Aromatic series. **(12 Marks)**

b. Explain the reasons for looking for alternative fuels for IC engines. **(04 Marks)**

c. What is bio-gas? How a dual fuel bio-gas operated diesel engine works? **(04 Marks)**

6 a. How are the injection systems classified? Describe them briefly. What are the limitations of an air injection system? **(10 Marks)**

b. What is the necessity of cooling of IC engines? Explain any one method of cooling. **(05 Marks)**

c. With a neat sketch, explain the Pintaux nozzle. Discuss its merits. **(05 Marks)**

7 Write short notes on the following :

a. Turbo charging b. Stratified charge engine

c. Multifuel engine d. Supercharging **(20 Marks)**

8 a. What are the main sources of pollutants from a gasoline engine? Explain. **(06 Marks)**

b. What are the methods of controlling NO_x? Explain. **(08 Marks)**

c. Explain the thermal reactor package, with a sketch. **(06 Marks)**

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