KHULNAUNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4thYear 1st Term Examination, 2018
ME 4025
(Finite Element Method)

Time: 3 Hours.   Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
     ii) Figures in the right margin indicate full marks.
     iii) Assume reasonable data if any missing.

SECTION – A

1(a) Show that the stiffness matrix for a bar element in local coordinate is   15
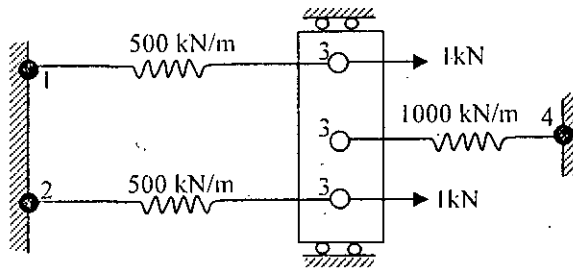
$$[K] = \frac{AE}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

Where symbols have their usual meaning.

1(b) For the spring assemblage shown in the figure, determine the unknown displacements   20
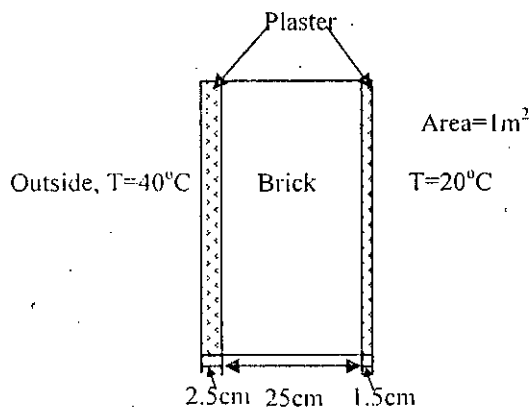and reaction forces.

2(a) Derive the basic differential equation for one dimensional heat conduction.   15

2(b) For the composite wall of a house as shown in the figure, determine the temperatures at   20
the interfaces. The wall is composed 2.5 cm thick plaster wall (k=0.20 w/m-°C) on the
outside, a 25 cm thick brick (k=0.25 w/m-°C) and a 1.5 cm plaster wall (k=0.20 w/m-
°C) on the inside. Assume the inside room temperature is 20°C and the outside room
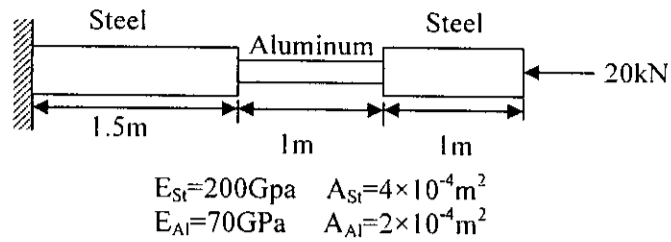temperature is 40°C. Consider one dimensional heat flow through the wall thickness.

3(a) For combined spring and bar elements shown in the figure, determine the displacements   20
and reactions. Both bars have E = 210 GPa and A = 5.0×10⁻⁴ m². The spring stiffness is
K = 2000 kN/m.
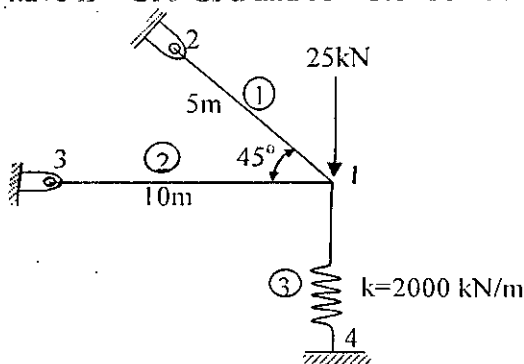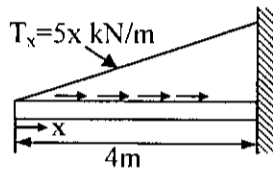
3(b) For the bar assemblage shown in figure, determine the nodal displacements, the forces 15 in each element and the reactions.

Steel | Aluminum | Steel
|← 20kN

1.5m
1m
1m

$E_{St}=200Gpa \quad A_{St}=4\times10^{-4}m^2$
$E_{Al}=70GPa \quad A_{Al}=2\times10^{-4}m^2$

4(a) For the rod loaded axially as shown in the figure, determine the axial displacement at 17 the midpoint of the rod. Let $E = 210$ GPa and $A = 6.00\times10^{-4}m^2$.

$T_x=5x$ kN/m

x

4m

4(b) For the beam shown in figure, determine the nodal displacements and rotations in terms 18 of EI.

50 kN

2m
2m
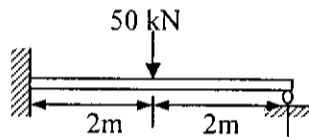
SECTION - B

5. For the beam shown in figure, determine the nodal displacements and rotations. 35

4kN/m

2kN/m

$E=70GPa$
$A=3\times10^{-2}m^2$
$I=3\times10^{-4}m^4$

2m
3m
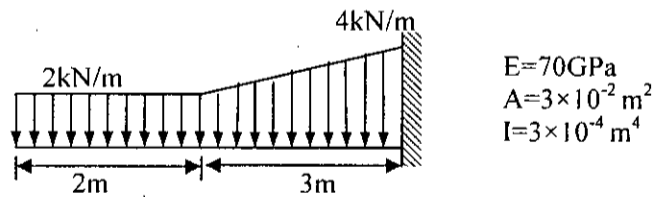
6. For the rigid frame shown in figure, determine the displacements and rotations of the 35 nodes. Consider $E = 210$ GPa, $A = 2\times10^{-2}m^2$, $I = 2\times10^{-4}m^4$

200kN.m

②

2

5m

3

①
4m
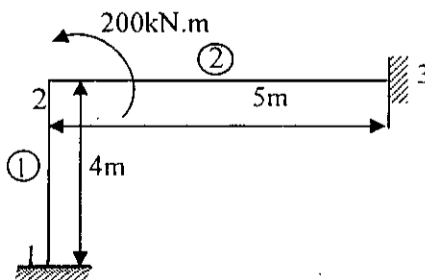
7(a)   Derive the differential equations of equilibrium in two dimensions.   15

7(b)   For the following stress tensor field, what body force distribution is needed to maintain   20
        equilibrium?

$$\begin{bmatrix} 10x^3y & y + 5z^2 & x + 6y^2 \\ y + 5z^2 & 21x^3 & -8x^2z \\ x + 6y^2 & -8x^2z & 9y + z \end{bmatrix}$$

8   Evaluate the stiffness matrix for the elements shown in figure. The coordinates are   35
        given in units of millimeters. Assume planes stress condition, E = 210 GPa, v = 0.25
        and f = 10 mm. If the nodal displacements are given as,

$$u_1 = 2.0 \text{ mm}, \qquad v_1 = 1.0 \text{ mm}$$
$$u_2 = 0.5 \text{ mm}, \qquad v_2 = 0.0 \text{ mm}$$
$$u_3 = 3.0 \text{ mm}, \qquad v_3 = 1.0 \text{ mm}$$
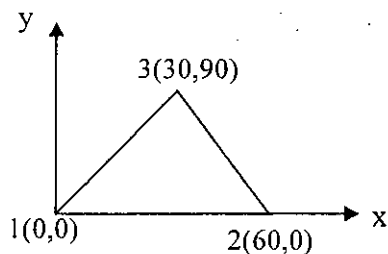
Determine the principle stresses.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2018
ME 4051
(Operations research)
Time: 3 Hours.   Total Marks: 210
N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

1(a) What is linear programming (LP) problem? Write down the characteristics of LP   07
Problem.

1(b) Minimize, $Z = c_1 x_1 + c_2 x_2$ 08

Subject to. $a_{11}x_1 + a_{12}x_{12} \leq b_1$

$a_{21}x_1 + a_{22}x_{22} \geq b_2$

Discuss what are meant by Z, c_1, c_2, $x_1, x_2, a_{11}, a_{12}, a_{21}, a_{22}$.

1(c) A company manufacture two types of products X and Y. The raw materials required for   20
one unit of product X is 10kg and for Y is 8 kg. The machine hour required for each
product of X is 5 hours and for Y is 7 hours. The total amount of raw materials and
machine hours available are 400kg and 240 hours respectively. The demand for product
X is almost 30 units. The profit for product X and Y are Tk 800 and Tk 600
respectively. Formulate this problem as mathematical model to maximize profit.

2(a) While solving a LPP by Simplex method, what indicates by each of the following   15
situations? Explain with example:

(i)   Unbounded solution,
(ii)   Degenerate solution,
(iii)   Alternate solution and,
(iv)   Infeasible solution

2(b) What is meant by solution space? Solve the following problem by graphical method.   20

Maximize $z = 2x_1 + 5x_2$

Subject to, $x_1 + x_2 \leq 4$

$4x_1 + 3x_2 \leq 12$

$-x_1 + x_2 \geq 1$

$x_1 \geq 0, x_2 \geq 0$

3(a) Why a dual problem is used in management decision making? Write the dual of the   15
following primal problem.

Miximize $z = 5x_1 + 6x_2$

Subject to:

$x_1 + 2x_2 = 5$

$-x_1 + 5x_2 \geq 3$

$4x_1 + 7x_2 \leq 8$

x_1 unrestricted

$x_2 \geq 0$

3(b) Solve the following problem by dual simplex method   20

Miximize

$$Z = 2x_1 + 2x_2 + 4x_3$$

Subject to, $2x_1 + 3x_2 + 5x_3 \geq 2$

$$3x_1 + x_2 + 7x_3 \leq 3$$

$$x_1 + 4x_2 + 6x_3 \leq 5$$

$$x_1, \ x_2, \ x_3 \geq 0$$

4. What is meant by balanced and unbalanced transportation problem? Find out the initial   35
basic feasible solution of the following transportation problem by (i) North West Corner
rule (ii) the Least cost method and (iii) Vogel's approximation method.. Also find the
optional solution of the problem.

Source	Destination			Supply
	I	II	III	Capacity
A	2	7	4	5
B	3	3	1	8
C	5	4	7	7
D	1	6	2	14
Demand	7	9	18	

SECTION - B

5(a) Define a queuing problem and give at least 5 distinct examples.   10

5(b) For a single server queuing model with Poisson arrival and exponential service and with   25
unlimited queue, deduce the formula for;

(i) Mean number of units in system

(ii) Mean waiting time in queue under steady state condition.

Thus find the values of service rate of 6 units/hour and arrival rate of 4 units/hours.
Define the symbols you used.

6. Mr. Farid has to decide whether or not to drill a well on his farm. In this village, only   35
40% of the wells drilled were successful at 69m of depth. Some of the farmers who did
not get water at 69m, drill further up to 85m, but only 20% struck water at 85m. Cost of
drilling is Tk. 16 per meter. Mr. Farid estimated that he would pay Tk. 18,000 during a
5 years period in the present value terms, if he continues to buy water from the neighbor
rather than go for the well which would have a life of 5 years. Mr. Farid has three
decisions to make.

(i)   Should he drill up to 69m,
(ii)   If no water is found at 69m, should he drill up to 85 m? and
(iii)   Should he continue to buy water from his neighbor?

Draw up an appropriate decision tree and determine his optimal decision.

7(a) What is meant by game? Write down the characteristics of a game. 08

7(b) Briefly explain the following terms: 09

(i) Saddle point (ii) Payoff matrix (iii) Pure strategy.

7(c) Solve the following game graphically: 18

	B1	B2	B3
A1	1	3	12
A2	8	6	2

8(a) What is dynamic programming? Briefly explain the basic elements of dynamic programming. 08

8(b) A student has to take three examinations in three courses A, B and C. He has three days 27 available for study. He feels it would be best to devote a whole day to the study of the same course, so that he may study a course one day, two days and three days or not at all. He estimates of the grades may get on the basis of this study are as follows:

Study days	Course		
	A	B	C
0	0	1	0
1	1	1	1
2	1	3	3
3	3	4	3

How would he plan his study to maximize the sum of grades? Solve the problem by using dynamic programming technique.

KHULNAUNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4thYear 1st Term Examination, 2018
ME 4105
(Automobile Engineering)
Time: 3 Hours.   Total Marks: 210
N.B. i) Answer any THREE questions from each section in separate scripts.
     ii) Figures in the right margin indicate full marks.
     iii) Assume reasonable data if any missing.

SECTION – A

1(a) Outline the major components of an automobile and explain the functions of each of 12
them.

1(b) What are the basic types of piston ring? How many of them are used in modern engine? 06
Why?

1(c) Write short notes on: 09

(i) Cylinder block   (ii) Piston and Piston ring   (iii) Crank Shaft

1(d) Why suction valve is larger than the exhaust valve? Mention the firing order of 4- 08
cylinders and 6-cylinders CI engine.

2(a) Why turbocharger is used in modern automobile? Explain how its work with neat 10
sketch?

2(b) Why rich mixture is necessary for starting of an automobile? Describe the operation 15
principle of an accelerating circuit of a carburetor in SI engine with neat sketch.

2(c) What are the advantages of Petrol injection system? Draw a fuel injector mentioning its 10
different parts.

3(a) Mention the basic purpose of antifreeze in the cooling system. 06

3(b) What is sludge? How and why does it form? How can it be prevented? 10

3(c) Mention the purpose and types of engine cooling system. Describe a radiator and 12
explain how it operates?

3(d) Mention the causes of knocking in SI and CI engines. 07

4(a) What are the different electrical systems needed in an automobile? Describe the starting 10
system with neat sketch.

4(b) What is ampere-hour rating? How does a heavy duty lead acid type of battery can be 12
constructed? Explain with neat sketches.

4(c) What is meant by alternator? What are the advantages of alternator over dynamo? 06

4(d) Draw and label the electronic ignition system of an automobile. 07

SECTION - B

5(a) How power of an automobile transfer from engine to wheel? Describe with necessary 12
sketch.

5(b) Why clutch system is used in vehicle? Describe the working principle of a diaphragm- 13
spring clutch with neat sketch.

5(c) Why differential gear is used in vehicle? How does it work? 10

6(a) What is hydraulic brake and how does it work? 10

6(b) Why power brake is used? Describe the operation principle of a power brake. 07

6(c) What are the functions of the following items: 08

        (i) Adjustable Screw   (ii) Master cylinder buckets

        (iii) Brake shoe lining   (iv) Air bleeding of brake line

6(d) Show the power flow in second speed gear. 10

7(a) Explain the necessity of using CV joint, Universal joint and suspension system in an 09
automobile.

7(b) What are the elements of front wheel geometry? Describe its importance. 10

7(c) Why springs are used in the suspension system? Describe the operation principle of a 11
shock absorber with neat sketch.

7(d) What is hybrid car? Describe how does it work? 05

8(a) What is catalytic converter? How does it work in the car exhaust system? 08

8(b) Discuss the merits and demerits of radial tyre over a bias ply tyre. 08

8(c) What is a turbocharger? How does it work? Mention its advantages. 09

8(d) What are meant by IC engine pollution and emission? Describe any pollution control 10
system.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2018
ME 4105
(Applied Thermodynamics)
Time: 3 Hours.   Total Marks: 210
N.B.   i)   Answer any THREE questions from each section in separate scripts.
       ii) Figures in the right margin indicate full marks.
       iii) Assume reasonable data if any missing.

SECTION – A

1(a)   Discuss the relative advantages and disadvantages of closed and open cycle gas turbine.   07

1(b)   For closed cycle constant pressure gas turbine, show that the optimum pressure ratio is equal to the square root of the maximum pressure ratio.   10

1(c)   What are the requirements of a good combustion chamber in open cycle gas turbine?   06

1(d)   A gas turbine plant operates with lower and upper temperature limits being 27°C and 920°C. What would be the optimum pressure ratio, if the turbine is to be operated for maximum power output? For the pressure ratio thus calculated, determine the plant efficiency and work ratio.   12

2(a)   How does rocket propulsion differ from jet propulsion?   05

2(b)   Show that the efficiency of a rocket propulsion can be expressed as, $\eta_{rp} = \dfrac{2\sigma}{1+\sigma^2}$, where σ is the ratio of aircraft velocity to jet velocity.   12

2(c)   With a neat sketch, describe the working principle of Ramjet propulsion system. What is meant burning?   10

2(d)   Explain with neat sketch the restricted and unrestricted burning of propellant in rocket propulsion.   08

3(a)   Describe the principle of action of stream turbine. Write down the fundamental difference between impulse turbine and reaction turbine.   07

3(b)   In an impulse turbine the fixed nozzle angle is α, the blade inlet and outlet angles are β_1 and β_2 respectively. The blade velocity coefficient is k, show that the diagram efficiency is, $\eta_d = (1 + kC)\dfrac{Cos^2\alpha}{2}$, where $C = \dfrac{Cos\beta_2}{Cos\beta_1}$.   12

3(c)   The blade speed of a single ring impulse blading is 300 m/sec and the nozzle angle is 20°. The isentropic heat drop is 473 kJ/kg and the nozzle efficiency is 0.85. The blade velocity coefficient is 0.7 and the blades are symmetrical. Draw the velocity diagram and calculate the followings for a mass flow rate of 1 kg/sec.   16

       (i)   The axial thrust on the blading,
       (ii)   Steam consumption rate for a mechanical efficiency of 90%,
       (iii)   Blade (Diagram) efficiency and,
       (iv)   Energy loss in blade friction.

4(a)   What are the various types of losses encountered in steam turbine? Briefly describe disc friction loss.   07

4(b) From the expression for blade outlet angle, show that in reaction turbine both impulse and reaction part contribute to the final absolute velocity?   08

4(c) Why turbine governing is necessary? Explain briefly the throttle control governing with neat sketch.   10

4(d) Why reheat factor for a multistage impulse turbine is always greater than unity?   10

SECTION - B

5(a) What are the parameters to be recorded during engine performance test and what are the parameters to be discussed on performance study? Explain.   10

5(b) Draw bhp, bsfc and BThEff curve versus engine speed. Discuss variation of bscf with load (bhp).   07

5(c) The air flow to the four cylinder four stroke petrol engine is measured by means of 7.5 cm diameter sharp-edged orifice, C_d=0.60. During the test on the engine the following data were recorded: 18

Bore=11cm, stroke=13cm, engine speed=2250rpm, brake power=36kW, fuel consumption=10.5 kg/hr, calorific value of the fuel=42,000kJ/kg, pressure drop across the orifice is 4.1cm of water. Atmospheric temperature and pressure are 15°C and 1.013 bar; Calculate;

   (i)   Thermal efficiency on the basis brake power,
   (ii)   Brake mean effective pressure.
   (iii)   Volumetric efficiency based on free air condition.

6(a) What is combustion? Describe the terms: (i) pre-ignition, (ii) auto-ignition and (iii) self-ignition.   10

6(b) Distinguish between knock and detonation.   05

6(c) Describe the theory of auto-ignition for knock in SI engine.   10

6(d) Briefly discuss the history of combustion chamber design for Spark Ignition engine.   10

7(a) "Factors tending to increase detonation in SI engine tend to reduce knocking in CI engine" Justify the statement.   10

7(b) What are the functions of combustion chamber? State the requirements of designing the combustion chamber of a CI engine for (i) high thermal efficiency (ii) smooth engine operation.   12

7(c) What are the different methods of generating swirl in CI engine? Describe compression swirl and induction swirl with their advantages and disadvantages.   13

8(a) What is meant by scavenging process? What are the different types of scavenging pump used in two stroke engine? Describe one of them with neat suitable sketch.   10

8(b) What are the methods of turbo-charging in four stroke CI engine? Write down the advantages of pulse turbo-charging.   07

8(c) Define anti-knock and pro-knock. What is the role of TEL in improving knock rating of gasoline?   08

8(d) With neat sketch describe the working principle of Bosch individual pump system for injecting fuel in CI engine.   10

KHULNAUNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4thYear1st Term Examination, 2018
ME 4127
(Operations Management)

Time: 3 Hours.   Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
     ii) Figures in the right margin indicate full marks.
     iii) Assume reasonable data if any missing.

SECTION – A

1(a) Define production and production process. Explain the input output model of a production process. 12

1(b) Define management process. Also describe different types of production system. 12

1(c) Describe the role of operation management in an organization 11

2(a) Define and explain the following terms: 08

    (i) Depreciation and,
    (ii) Appreciation.

2(b) Differentiate between: 08

    (i) Direct and Indirect Costs and,
    (ii) Fixed and Variable Costs.

2(c) KUET authority wants to purchase a lathe machine and advertizes in a newspaper. Two companies bid for the proposal and these are follows: 19

	Company X	Company Y
Initial cost of the machine	$10,000	$12,000
Yearly operating cost	$1,000	$700
Economic life of the machine	5 years	7 years
Salvage value after economic life	$500	$400

Consider the rate of annual interest 12 percent, which lathe machine should be purchased by KUET authority?

3(a) What is work study? Write down the objectives and advantages of work study. 10

3(b) Write short note on (i) Process flow diagram; (ii) Man machine chart and (iii) Process block diagram. 15

3(c) What is meant by THERBLIG? How many are they? Mention ten of them with symbols. 10

4(a) Define project. How is it different? Why is it used? 08

4(b) What are the key decisions of a project? 06

4(c) Write down the responsibilities of a project manager. 06

4(d) Eliminate the redundant activity and draw AON network for the following information 15

Activity	Immediate predessor
A	--
B	A
C	A
D	B, C
E	B, D
F	C, D
G	B, D, E, F

SECTION - B

5(a) Define layout planning. Briefly describe the principles of layout planning.   06

5(b) Differentiate process and product layout.   06

5(c) The city Bank decided to relocate its Khulna Branch office to another city. Three   23
alternative sites: Barisal, Jashore and Kushtia are being considered. The total annual
costs are estimated as follows: Barisal Tk 6.7 million, Jashore Tk 6.2 million and
Kushtia Tk 6.3 million. The most important subjective factors are: (i) Govt.
bureaucracy; (ii) Political stability and (iii) Service availability. All these are viewed as
equally important. It is also considered that objective factors are equally important as
subjective factors. The following results were obtained by pair wise comparison.

Site	Govt. Bureaucracy			Political Stability			Service Availability		
	1	2	3	1	2	3	1	2	3
Barisal	0	1	-	1	1	0	1	0	-
Jashore	1	-	1	1	-	0	1	-	1
Kushtia	-	0	1	-	0	1	-	1	0

(i)   Determine the objective factor measures for each only
(ii) Determine the subjective factor measures for each only.
(iii) Select the best city by Brown Gibson method.

6(a) What is demand forecasting? What are the methods used for demand forecasting?   08

6(b) Enumerate steps of forecasting process.   07

6(c) Number of Toyota Premio car sold quarterly in Khulna city is as shown below: 20

Years	Quarters			
	Q_1	Q_2	Q_3	Q_4
2014	25	33	42	35
2015	36	48	52	42
2016	50	63	62	30
2017	65	72	74	62

Find:

(i)   A least square trend line and calculate the standard error of the estimate.
(ii) Using the regression line obtained above, find the forecast for the year 2018 and
specify a 95% confidence level.

(iii)From past years, the typical seasonal index values have been estimated as
$$S_{Q1} = 0.85, \quad S_{Q2} = 0.95$$
$$S_{Q3} = 1.05, \quad S_{Q4} = 0.80$$
Using these seasonal index determine the forecast for each quarter of 2018.

7(a) Derive the formula for determining total inventory cost by EOQ model with specifications. 15

7(b) The demand for certain items is 55000 units/year. Each unit costs $80 and inventory 20 carrying charges have been estimated at 20 percent of inventory value. The ordering cost is $400 per shipment. Determine the optimum policy for the management.

8(a) Define MRP. Explain the inputs and outputs of a MRP system with appropriate 10 diagram.

8(b) A manufacturer of a toy requires the parts as shown in the accompanying product tree. 25
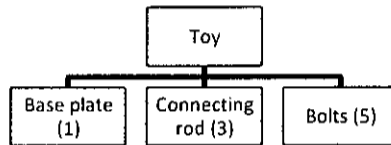
The master production schedule for the next 8 weeks calls for 120 toys in week-3, 200 in week-5, 140 in week-6 and 390 in week-8. The lot size, lead times and initial inventory are as shown below:

Part Name	Lot Size	Lead Time (Week)	Initial Inventory
Base plate	600	2	300
Connecting rod	1000	1	500
Bolt	1500	1	800

Determine the material requirements planning schedule for the parts.