Second Semester Examination
Academic Session 2017/2018

May/June 2018

EPM322 – Industrial Engineering
[Kejuruteraan Industri]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **TEN [10]** printed pages before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **SEPULUH [10]** mukasurat bercetak sebelum anda memulakan peperiksaan.]*

INSTRUCTIONS : Answer **ALL FIVE [5]** questions.
*[ARAHAN : Jawab **SEMUA LIMA [5]** soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1.   [a]   **Contrast single factor and multifactor productivities. Hence, identify FOUR (4) challenges in assessing multifactor productivity for a manufacturing firm.**

Bandinkan produktiviti faktor tunggal dan pelbagai faktor. Seterusnya, kenalpasti EMPAT (4) cabaran dalam penilaian produktiviti pelbagai faktor untuk sebuah firma pembuatan.

(**30 marks**/*markah*)

[b]   **A soy milk manufacturing company seeks advice from an external consultant regarding its business and production processes. The final consulting report describes several steps to increase productivity including implementation of cutting-edge processing techniques through more efficient filtering systems. Table Q1[b] compares the existing production system and production system proposed by the consultant.**

Satu syarikat pembuatan susu soya memperoleh nasihat daripada perunding luar mengenai proses perniagaan dan pengeluarannya. Laporan perundingan akhir menyenaraikan beberapa langkah untuk meningkatkan produktiviti termasuk mengunakan teknik pemprosesan canggih melalui sistem penapisan yang lebih cekap. Jadual S1[b] membandingkan 2sistem pengeluaran sedia ada dan sistem pengeluaran yang dicadangkan oleh perunding.

Table Q1[b]
Jadual S1[b]

	Existing System *Sistem sedia ada*	**Proposed System** *Sistem yang dicadang*
Workers *Pekerja*	12	9
Soy milk output/hour *Pengeluaran susu soya/jam*	4000 L	5000 L
Wage rate/hour *Kadar upah/jam*	RM 10	RM 10
Filtration cost/hour *Kos penapisan/jam*	RM 120	RM 210
Operation hour/day *Jam operasi/hari*	8	8

(i)   **Calculate the labor productivity for both systems.**

Kira produktiviti pekerja untuk kedua-dua sistem.

        (ii)   **Find the multi factor productivity for both systems.**

                Cari produktiviti pelbagai faktor untuk kedua-dua sistem.

        (iii)   **Assuming that daily sale of the company is estimated to be 35,000L sold at RM 2.40 /L, provide justification whether the productivity improvement proposed by the external consulting company shall be accepted.**

                Andaikan jualan harian syarikat ini dianggarkan 35,000L yang dijual pada harga RM 2.40 /L, berikan alasan sama ada penambahbaikan produktiviti yang dicadangkan oleh syarikat perunding luaran diterima-pakai.

                                              (50 marks/*markah***)**

[c]   **Implementation of 'Green Productivity' in the manufacturing system could improve the profitability of a manufacturing plant without compromising the productivity of the plant. Provide TWO (2) arguments to support the profitability of implementing 'Green Productivity'.**

        Pelaksanaan 'Produktiviti Hijau' dalam sistem pembuatan satu kilang pembuatan dapat meningkatkan keuntungan tanpa menjejaskan produktiviti kilang ini. Berikan DUA (2) pendapat untuk menyokong keuntungan daripada pelaksanaan 'Produktiviti Hijau'.

                                            (20 marks/*markah***)**

2.   **[a]**   **Empowerment in the workplace could be a great motivational strategy by entrusting the employees with the power they need to make decisions and behave according to their understanding of organizational goals and objectives, such as empowering a kaizen team to make improvement continuously to a production line.**

        Pemberian kuasa di tempat kerja boleh menjadi strategi motivasi yang hebat dengan mengamanahkan pekerja dengan kuasa yang mereka perlu untuk membuat keputusan dan bertindak berdasarkan kefahaman mereka tentang matlamat dan objektif organisasi, seperti memberi kuasa kepada satu kumpulan kaizen untuk melakukan penambahbaikan berterusan dalam barisan pembuatan.

        Do you agree to the statement relating to the empowerment in the workplace? Justify your opinion with appropriate motivational theory(ies).

        Sejauh manakah anda bersetuju dengan pernyataan yang berkaitan dengan pemberian kuasa di tempat kerja? Jelaskan pendapat anda dengan teori(-teori) motivasi yang sesuai.

                                            (40 marks/*markah***)**

[b] **Reward or incentive should be given to the kaizen group (as mentioned in Q2[a]) who had achieved outstanding performance in improvement project so that the kaizen team will always be motivated and performing.**

Ganjaran atau insentif harus diberikan kepada kumpulan kaizen (seperti yang disebutkan dalam Q2[a]) yang telah mencapai prestasi cemerlang dalam projek penambahbaikan supaya kumpulan kaizen itu akan sentiasa bermotivasi dan berprestasi.

(i) **Relate the NECESSITY of giving reward or incentive in the statement with appropriate motivational theory(ies).**

Kaitkan KEPERLUAN pemberian ganjaran atau insentif dalam pernyataan dengan teori(-teori) motivasi yang sesuai.

(ii) **Discuss TWO (2) reasons that the incentive scheme may fail to promote motivation regarding the statement above.**

Bincangkan DUA (2) sebab bahawa skim insentif mungkin gagal untuk menggalakkan motivasi mengenai pernyataan di atas.

(40 marks/*markah***)**

[c] **Briefly explain how the job enlargement and job enrichment will help to improve workers' motivation and morale.**

Terangkan secara ringkas bagaimana pembesaran kerja dan pengkayaan kerja akan membantu dalam meningkatkan motivasi dan semangat pekerja-pekerja.

(20 marks/*markah***)**

3. **[a]** **Discuss TWO (2) factors that may influence the assignment of a particular closeness rating to a pair of departments in plant layout planning.**

Bincangkan DUA (2) faktor yang boleh mempengaruhi pemberian kadar kedekatan tertentu kepada sepasang jabatan dalam perancangan susun atur kilang.

(20 marks/*markah***)**

[b] **A manufacturing plant has five production departments: M (milling), D (drilling), T (turning), G (grinding) and F (finishing). Products are routed for processing through these departments according to the quantities and sequences indicated in the Table Q3[b].**

Sebuah kilang pembuatan mempunyai lima jabatan pengeluaran: M (pemilan), D (pengelulian), T (larik), G (penyisaran) and F (pengemasan). Produk-produk dijujukkan untuk diproses melalui jabatan-jabatan ini dalam kuantiti dan urutan yang ditunjukkan dalam Jadual S3[b].

Table Q3[b]
Jadual S3[b]

Product *Produk*	Quantity per day *Kuantiti sehari*	Sequence *Urutan*
A	40	M-D-F
B	50	T-G-F
C	60	G-F
D	70	M-D-M-G-F
E	30	T-M-F
F	10	M-T-G

(i)   **Construct the From-To chart for the data in Table Q3[b].**
      Bina carta Dari-Ke untuk data dalam Jadual S3[b].

(ii) **Develop the activity relationship chart for the five departments according to the From-To chart in Q3[a](i).**

      Bangunkan carta hubungan aktiviti untuk kelima-lima jabatan berdasarkan carta Dari-Ke dalam S3[a](i).

                                                                        (**40 marks/***markah*)

[c]   **A CNC machine shop has signed a contract with a new customer to produce three new types of products namely, product A, product B and product C. Sales forecasts for these products are: 52,000, 65,000 and 70,000 units per year, respectively. At present, the machine shop operates 50 weeks per year, 10 shifts per week, and 8 hours per shift. The machine shop has 3 CNC machines to cope with the new production demand. Based on current machine performance, the production rates for the three products can be estimated as, 12, 15 and 10 unit/hr and scrap rates are, 5%, 7%, and 9% respectively. It is anticipated that these CNC machines will be down for repairs on average 10 percent of the operating time.**

      Satu bengkel mesin CNC baru menandatangani kontrak dengan seorang pelanggan baru untuk menghasilkan tiga jenis produk baru iaitu produk A, produk B dan produk C. Ramalan jualan untuk produk-produk ini ialah: 52,000, 65,000 dan 70,000 unit setahun, masing-masing. Pada masa ini, bengkel mesin beroperasi 50 minggu setahun, 10 syif seminggu, dan 8 jam setiap syif. Bengkel mesin ini mempunyai 3 mesin CNC untuk menampung permintaan pengeluaran baru. Berdasarkan prestasi mesin semasa, kadar

pengeluaran bagi ketiga-tiga produk ini boleh dianggarkan sebagai, 12, 15 dan 10 unit sejam dan kadar sekerap masing-masing adalah, 5%, 7%, dan 9%. Mesin-mesin CNC ini akan dihentikan untuk pembaikpulihan sebanyak 10 peratus dari masa operasi secara purata.

(i)   **How many new CNC machines will be required to meet demand?**

Berapa banyak mesin CNC baru yang diperlukan untuk memenuhi permintaan?

(ii)   **If each machine requires a floor area of 30 m², and there is a 25% aisle allowance that must be added to the machine space, what is the minimum plant area that must be planned for the new machines?**

Sekiranya setiap mesin memerlukan kawasan lantai 30 m², dan 25% kawasan tambahan untuk lorong perlu ditambah ke ruang mesin, apakah kawasan kilang minimum yang mesti dirancang untuk mesin-mesin baru?

(40 marks/*markah***)**

The following **EXHIBIT 1** case study is for **Q4** and **Q5**. You are appointed as a consultant, thus your task will involve solving all the questions pertaining to the operation of the Lean Sdn. Bhd. plant. Read the case study to gather information/data before answering the questions.

Kajian kes berikut EXHIBIT 1 adalah untuk S4 dan S5. Anda telah dilantik sebagai perunding maka, tugas anda adalah untuk menyelesaikan semua persoalan tentang operasi loji Lean Sdn. Bhd. Baca kajian kes bagi mengumpul maklumat/data sebelum menjawab soalan.

EXHIBIT 1

OVERVIEW
Lean Sdn. Bhd. (LSB) produces bicycle for major brand names. The process of assembling the bicycles area carried out manually. *Figure 1* shows the production flow at LSB.

The demand of bicycle had increased tremendously and the most affected section is *Painting Section* because of the delay in waiting for the paint to dry before it can be sent to the next assembly section.

LSB also has the problem of inconsistency to meet its daily production output and the company has high overtime to complete their daily production schedule.
Based on the report from Marketing/Sales Department, the trend of bicycle order will keep on increasing hence this will affect LSB to meet the customer demand.

CURRENT OPERATION

LSB runs only 1 shift/day for 8 hours/shift with 1 operator for each production section. Work starts at 8.00 am and ends at 4.00 pm for 5 days a week. LSB has no work-in-process (WIP) at the end of the shift. All the WIP will be processed by doing overtime.

Each assembly section will request the parts from *Sub-Assembly Store* in the beginning of the shift except for *Painting Section*. Since it is an assembly process, the subsequent section will have to wait for the sub-assembled bicycle from the previous section.

WIP i.e. sub-assemblies parts and finished assembled bicycle are moved from one section to another section in a batch of 10 using manual trolley by a dispatch worker. The dispatch worker function is to move and take parts/sub-assemblies from *Sub-Assembly Store* to all the assembly sections and right up to *Warehouse*.

In order to meet the demand LSB requires their workers to work overtime. Constraint in overtime is that a worker can only work up to 16 hours per day. The labour law had stated that a worker must have minimum 8 hours of rest before commencing work after a continuous 16 hours of work.

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OBSERVATION AND FINDINGS
- Based from SWAG estimation historical data;
  - ❖ Current output for LSB is 150 units of bicycle per day.
  - ❖ Cycle time for sub-assembly task for each section is 1 minute.
  - ❖ Painting requires 0.5 minute and paint drying is 2 minutes.
  - ❖ Bicycle testing run requires 0.5 minute.

- Bottleneck occurs at *Painting Section* because *Frame Assembly Section* will complete all the 150 units of frame assembly.

- The high idling time at *Wheel Assembly Section* is due to the waiting time for the paint to dry and also at the *Frame Assembly Section* after they had completed the frame assembly.

- Although the working hours is 8 hours/shift, the productive man-hours available per shift is only 7 hours because of the 1 hour lunch break.

- The working environment is not well lighted and ventilation of the plant is not properly addressed hence it is quite hot and humid for an average worker to work in the current condition.

- You conducted a time study for each section in order to determine the actual cycle time and their performance rating. Following are the data collected:

  - ❖ *Frame Assembly Section*: 1 minute observation time at 100% performance rating.
  - ❖ *Painting Section*: 0.25 minutes observation time at 150% performance rating.
  - ❖ *Wheel Assembly Section*: 0.75 minutes observation time at 80% performance rating.
  - ❖ *Bicycle Testing Section*: 0.75 minutes observation time at 80% performance.
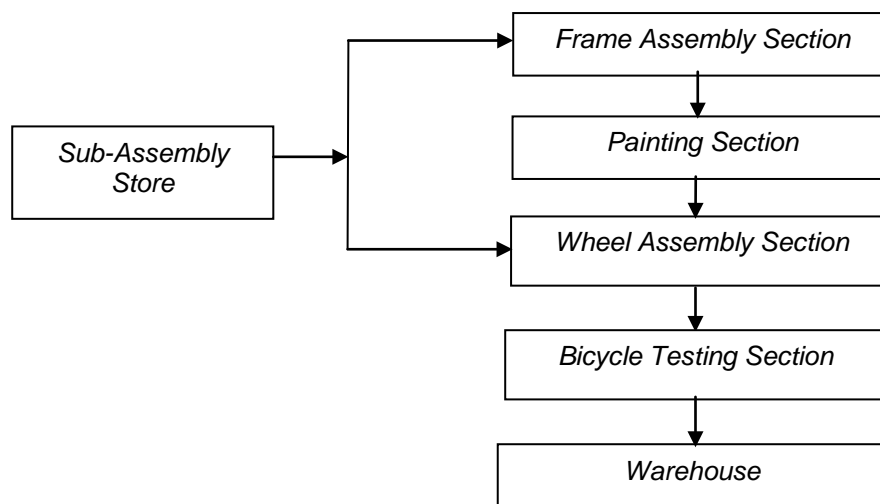 - ❖ The paint drying time is similar to the SWAG data i.e. 2 minutes.

Figure 1: LSB Bicycle Assembly Production Flow

4. [a] **Based from the information and data of the case study;**

Berdasarkan maklumat dan data kajian kes;

(i) **Construct a <u>detailed</u> "Process Flow Chart" for LSB with reference to Figure 1 and include the time required for each assembly section. For any task/activity where the time is not given, assume it negligible.**

Bina satu "Carta Aliran Proses" LSB yang <u>lengkap</u> dengan merujuk kepada "Figure 1"dan sertakan masa yang diperlukan untuk setiap seksyen pemasangan. Untuk kerja/aktiviti di mana masa tidak dinyatakan, sila anggap boleh diabaikan.

(50 marks/*markah)*

(ii) **Calculate the total time (in minutes) to complete the LSB current output of bicycle assembly per day from the SWAG estimation data.**

Kira jumlah masa (dalam minit) yang diperlukan untuk LSB menyiapkan keluaran terkini untuk pemasangan basikal sehari daripada data anggaran SWAG.

(15 marks/*markah)*

(iii) **Calculate the <u>total</u> productive man-hours available for one (1) shift and one (1) day for LSB.**

Kira <u>jumlah</u> waktu produktif pekerja-jam untuk satu (1) shift dan satu (1) hari bagi LSB.

(10 marks/*markah)*

[b] **In the case study mentioned that LSB had to do overtime to complete their daily production schedule. Use the SWAG estimation data for calculation purposes.**

Di dalam kajian kes ada dinyatakan LSB perlu membuat kerja lebih masa untuk menyiapkan jadual pengeluaran harian. Sila guna data anggaran SWAG untuk tujuan pengiraan.

(i) **Required total overtime (in hours).**
Jumlah kerja lebih masa yang diperlukan (dalam jam).

(10 marks/*markah)*

(ii)   **Cost of overtime per month if the rate is RM20.00 per hour.**
Kos lebih masa sebulan sekiranya kadar ialah RM20.00 sejam.

(15 marks/*markah***)**

5.   [a]   **From the time study data collected in the case study, calculate;**
Daripada data kajian masa yang dikumpulkan dalam kajian kes, kirakan;

(i)   **Normal time for one completed bicycle assembly.**
Masa normal pemasangan satu basikal yang lengkap.

(ii)   **Standard time for one completed bicycle assembly, given PFD allowances are 15%.**

Masa piawai pemasangan satu basikal yang lengkap, di mana kelegaan PFD diberikan adalah 15%.

(iii)   **Explain briefly THREE(3) criteria or situations that require PFD allowances.**

Terangkan secara ringkas TIGA(3) kriteria atau keadaan yang memerlukan kelegaan PFD.

(50 marks/*markah***)**

[b]   **Based on the calculated standard time in Q5[a](ii), calculate the total time to complete the daily output.**

Berdasarkan masa standard yang telah dikira dalam S5[a](ii), kirakan jumlah masa untuk menyiapkan pengeluaran harian.

(10 marks/*markah***)**

[c]   **Based on Industrial Engineering approach, give TWO (2) suggestions that will improve the LSB overall performance. State your reasoning for each suggestion.**

Berdasarkan pendekatan Kejuruteraan Industri, berikan DUA (2) cadangan untuk meningkatkan prestasi keseluruhan LSB. Nyatakan alasan anda untuk setiap cadangan.

(40 marks/*markah***)**

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