

**REFORM OF TECHNICAL SUBJECT EXAMINATION  
WITH MULTIPLE CHOICE- ESSAY WRITING EXAM FORMS  
CẢI CÁCH THI HẾT MÔN CÁC MÔN HỌC KỸ THUẬT  
BẰNG HÌNH THỨC THI KẾT HỢP TRẮC NGHIỆM- VIẾT LUẬN**

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**Abstract:**

*For ages, oral and essay writing exams have been used for evaluating the knowledge on technical subjects given to the students at Vietnam Maritime University (VIMARU) and other universities in Vietnam as well. These two examination forms showed a lot of weak points such as limited exam content, no objectiveness and big consumption of time in evaluation. It is the time a reform needed to be done.*

*Reform of technical subject examination with multiple choice- essay writing is presented in this article. This combined exam forms help to alleviate the limits of the traditional exams. It was proved by carrying out experiments at VIMARU from year 2003 up to now.*

*In this article, the methods of preparation of multiple choice-essay writing combined exam questionnaires, especially, multiple choice questionnaires of problems, and the organization of the combined exams are also studied and presented.*

**Tóm tắt:**

*Từ nhiều năm nay, thi vấn đáp và thi viết luận là những hình thức thi được trường ĐHHHVN nói riêng và các trường ĐH tại Việt Nam nói chung sử dụng rộng rãi để đánh giá chất lượng học tập của sinh viên sau mỗi môn học. Tuy nhiên, hai hình thức thi này đã thể hiện nhiều hạn chế như: nội dung môn học được kiểm tra trong mỗi đề thi rất hạn chế, việc chấm thi rất mất nhiều thời gian và công sức và kết quả thi không đảm bảo tính khách quan cao. Đã đến lúc phải tiến hành một cuộc cải cách thực sự trong phương cách thi, chấm thi và đánh giá chất lượng học tập của học viên.*

*Cải cách thi hết môn các môn học kỹ thuật bằng hình thức thi kết hợp viết luận- trắc nghiệm được trình bày trong bài báo khoa học này. Hình thức thi cải cách này giúp giảm bớt đáng kể những hạn chế của các hình thức thi truyền thống. Điều này đã được chứng minh qua một loạt các thử nghiệm, do tổ Cơ học máy- Khoa Cơ khí Động tàu thực hiện tại trường ĐHHHVN từ năm 2003 đến nay.*

*Trong bài báo khoa học này, các phương pháp soạn câu hỏi cho đề thi kết hợp viết luận – trắc nghiệm, đặc biệt là các câu hỏi trắc nghiệm về bài tập và những cách thức tổ chức thi theo hình thức thi cải cách cũng được nghiên cứu và trình bày.*

**1. Requirements and objectives of an examination reform at VIMARU**

Usually, oral and essay writing exams are used for evaluating the knowledge on learning subjects, especially technical ones which given to the students at VIMARU as well as other universities and colleges in Vietnam. With time, these two forms of exams seem to be unsuitable.

Because of time consumption and tiresomeness, the oral exam form has hardly been applied to the midterm or final exams of all technical subjects with the number of examinees large and increasing every year like of VIMARU.

And now, traditional essay writing exam forms are widely applied to almost exams at VIMARU, but beside some advantages as time spent for an exam is regulated and controlled and it is suitable for a huge number of examinees, they showed rather many disadvantages. One, the testing content in each exam questionnaire set which consists of some essay questions is rather

narrow; it cannot cover the whole subject because of exam time limit. Two, marking exam papers needs much time and work. Three, owing to the evaluating process not free from examiners' subjectivity, exam results are not full objective (the figure of students' petitions about their exam results certified it). And four, it is difficult to automate the process of marking exam papers.

At VIMARU and other schools as well, multiple choice exams have just been used for the subjects as foreign languages but others, especially, technical ones; because using only single multiple choice exam forms for evaluating the students' knowledge on such a subject is not quite reliable or adequate. Although multiple choice exams have a lot of strong points as it is easy to fully automate the process of marking exam papers, simple to ensure the objectiveness of the exam results and possible to test the whole content of a subject in a quite short exam time, they also have some radical weak points as it is impossible to get a really precise evaluation result; because of probability in choosing right answer options to exam questions and difficult to test the examinees' creativity and ability of self solving posed problems or profundity of understanding and applying the theory which they have learnt. In addition, the preparation of exam questionnaires requires a lot of work and time.

To improve the evaluation of examinees' knowledge on learning technical subjects, the first time, in VIMARU, a reform of examination has been carrying out with a combination of multiple choice and essay writing, of which the highlight is that the multiple choice of problems were applied to final exams. The reform aimed at making use of all advantages of both the two exam forms; namely, to increase the reliability of exam results through intensifying testing contents at unchanged limited exam time and improving the objectiveness in evaluation, reduce learning by rote, and decrease the time and work spent for marking exam papers.

## **2. Examination reform with combination of multiple choice (MC) and essay writing (EW)**

The most difficult matters of the reform are how to prepare the exam questionnaires for the multiple choice component, especially, multiple choice questions for the problem parts and to combine the two components: multiple choice and essay writing, so that they will be reliable and meet the requirements of technical subject final exams. These matters were hard studied, tried out, amended, adjusted and finally, well solved through successive exam experiments which are presented hereafter.

### **2.1 Exam experiments**

Since year 2003, successive experiments have been done on the final exams of a technical subject named Mechanics of Machines which has learning credits of 4.

The percentage of the MC- EW components of the combination was changed from 30% MC- 70% EW, 40% MC- 60% EW to 50% MC- 50% EW.

Also, the testing contents were different, with the spotlight application of multiple choice of problems of a technical subject to final exams, as below:

1. 30% MC theory - 70% EW (30% theory + 40% problem)
2. 40% MC problem- 60% EW theory
3. 50% MC theory- 50% EW problem
4. 50% MC problem - 50% EW theory

And four data were surveyed:

1. % subject content tested in an exam questionnaire set (%STC)
2. Exam result (ER): % very good (%VG), % good (%G), % average (%A), and total % pass (% P); ( $P = \% VG + \% G + \% A$ )
3. Mean time spent for marking an exam paper (T/EP)
4. Figure of petitions about exam results in percentage (% PR)

## 2.2 Experiment results

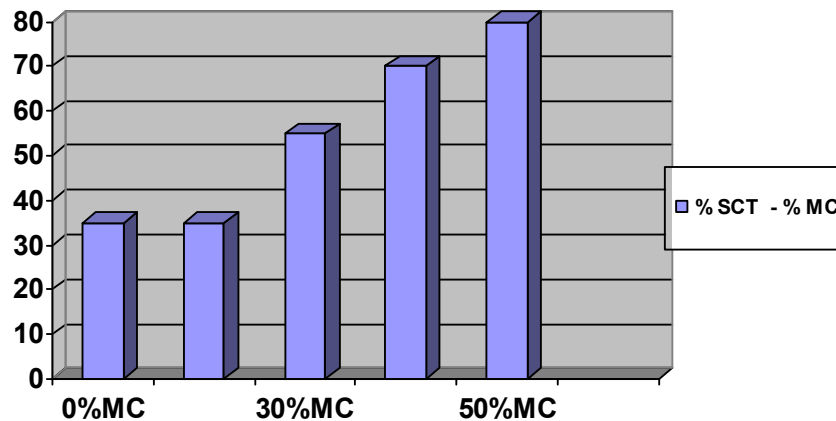
The data gained from the experiments in comparison with those from a couple of years before are shown in table 1 below:

**Table 1**

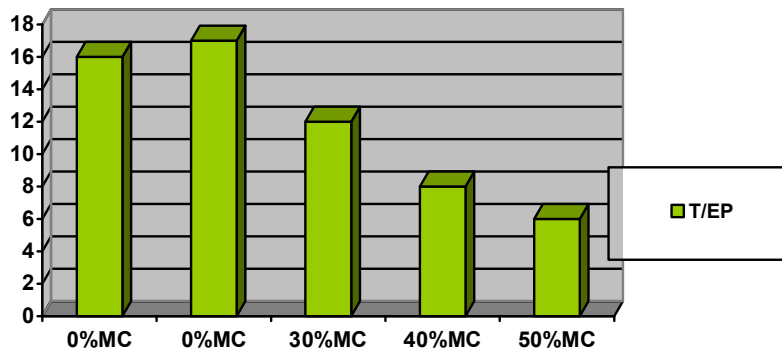
No	Acad year	% MC- % EW in a combd exam	%SCT	Exam time (min)	Numbr of exmnees	ER *% VG * % G *% A *% P	T/EP (min)	% PR
01	2001- 2002	0%MC- 100 % EW	35 %	90	223	5.5 % VG 26.7 % G 40.3 % A 72.5 % P	16	6.17 %
02	2002- 2003	0% MC- 100% EW	35 %	90	328	5.9 % VG 25.4 % G 45.1 % A 76.4 % p	17	7.09 %
03	2003- 2004	30% MC- 70% EW	55 %	90	434	3.1% VG 30.3 % G 41.6 % A 75 % P	12	4.25 %
04	2004- 2005	40% MC- 60% EW	70 %	90	511	2.7 % VG 31.5 % G 40.1 % A 74.3 % P	8	3.05 %
05	2005- 2006	50% MC- 50% EW	80 %	90	507	2.1 % VG 34.1 % G 38.7 % A 74.9 % P	6	1.68 %

For better comparison with the increase of % MC, these data are more explicitly shown in charts 01, 02, 03 and 04 below:

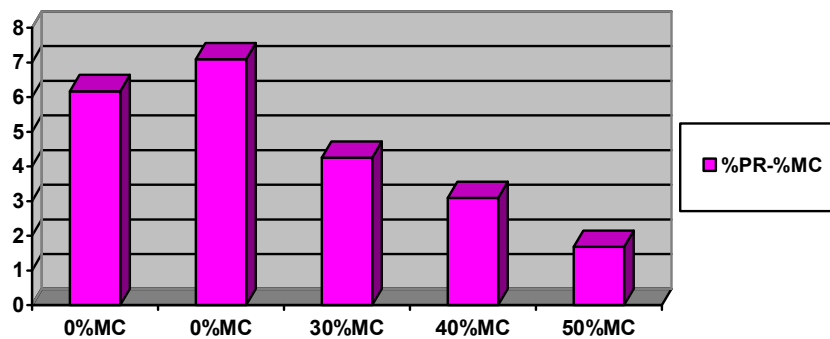
**Chart 01: % SCT - % MC**



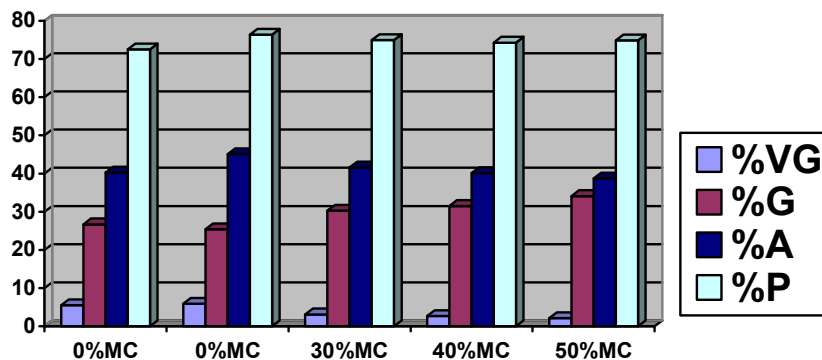
**Chart 02: T/EP- % MC (min)**



**Chart 03: % PR - % MC**



**Chart 04: % ER - %MC**



### 2.3. Assessment of experimental exams

The data collected from the successive experiments on the final exams of Mechanics of Machines verify the better of multiple choice- essay writing combined exams. These forms of exams allow making use of all the advantages and by the same time, reducing the disadvantages of the two singles. Combined exams are much less time-consuming and much less tiresome; because of the remarkably

shorter time and less work spent for marking exam papers (with the help of answer keys for the MC component, mean time spent for marking an exam paper with 50% MC - 50% EW is about a third of the time spent for that with 0% MC - 100% EW). Also, the exam results are more objective; certified by the figure of examinees' petitions decreased sharply (from 7.09% with 0%MC - 100% EW to 1.68% with 50% MC - 50% EW). Furthermore, the reliability of the reformed exams is visibly improved; shown through the much larger subject content examined in an unchanged

limited exam time (from 35% with 0%MC - 100% EW to 80% with 50% MC - 50% EW), and exam results with % P vibrated lightly (about values of 74 %). % G increased continuously (from 26.7% G with 0% MC - 100% EW to 34.1% with 50% MC - 50% EW). % VG decreased noticeably with larger % MC (from 5.9% VG with 0% MC - 100% EW to 2.1% with 50% MC - 50% EW); this can be explained by the difficulty and testing subject content increased significantly with the raise of %MC (therefore only few really outstanding students who well master the whole subject, can do excellently and have the very good marks). Once more, it verifies the better reliability of the combined exam forms and the reduction of learning by rate.

Through the successive experiments, the exams combined 50% MC & 50% EW give the most optimal option. With the data of %SCT, %ER, T/EP and %PR, the combination ensures the optimum for the examination reform. More than 50 % MC in a combined exam is not introduced to the technical subject; because the probability can make the exam results less truthful and other standards and skills as profundity of self- presentation of the knowledge, self- ability and self-creativity in applying the theory to solving the problems, etc, are insufficiently tested.

### 3. Questionnaire preparation for MC- EW combined exams

As mentioned before, the MC-EW combined exam questions play a decisive role in assessing the reliability of exam results. Therefore, they ought to be thoroughly prepared.

#### 3.1 Questionnaire preparation for essay writing component

The questions for the EW component are essay questions. They are unchanged in comparison with those of the traditional single essay writing exams. For them, the most significant is how to join the MC questions to create well combined exam questionnaire sets which satisfy the requirements of an exam.

#### 3.2 Questionnaire preparation for MC component

##### 3.2.1 Testing content

##### 3.2.1.1 Theory part

With own specific characteristics, the MC exam questions for the theory part of a technical subject are aimed at testing the examinees' knowledge on the following matters:

- Precise understanding and good memory for the concepts, definitions, theorems, principles, classifications, characteristics, uses, applications and so on.
- Ability of logical analysis, synthesis and inference for quick selection of the right answer option for a formula, diagram, graph, design approach, and etc.

##### 3.2.1.2 Problem part

Also, with own specific characteristics, the MC exam questions for the problem part of a technical subject are prepared for testing the examinees' skills on the following matters:

- Accurate understanding and applying the theory of the subject to solve a technical problem, but not the skill of calculating precise results.
- Ability of logical analysis, synthesis and inference for quick selection of the right approach option for solving a type of technical problems.

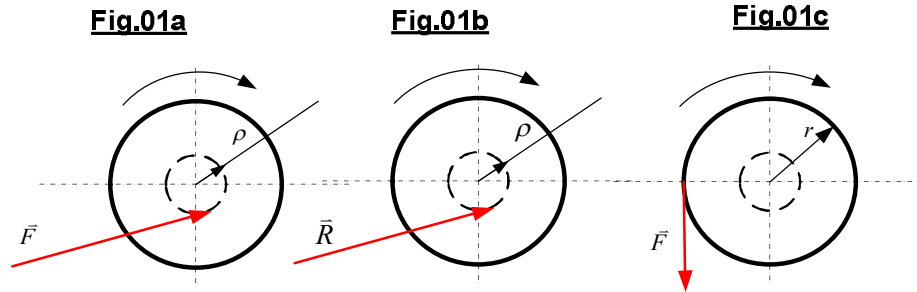
#### 3.2.2 Types of MC exam questions

The types of MC exam questions used for building up the questionnaires of the MC component can be different as **Most Accurate**, **True/False**, **Extension** and **Odd One Out**, and etc. The larger the number of the answer options in each question is the more reliable the exam results are. Nevertheless, the experiments showed that the suitable number of the options is not less than 3, and not more than 7 for technical subject exams in a rather short limited exam time; e.g., 90 minutes as set for the final exam of Mechanics of Machines. Hereafter, some types of MC exam questions applied to the subject are presented.

##### 3.2.2.1 The MC questions for the theory part - examples

##### • True/False

Questions require selecting either the **True (Correct)** or the **False (Incorrect)**; e.g.:



a. **T/F:** At rotating surfaces, the friction ( $\vec{F}$ ) is tangential to a circle of radius  $\rho$  termed the friction circle. The point of tangency is such that the moment of the force about the centre opposes the relative rotation, Fig. 01a.

b. **T/F:** At rotating surfaces, the reaction ( $\vec{R}$ ) is tangential to a circle of radius  $\rho$  termed the friction circle. The point of tangency is such that the moment of the force about the centre opposes the relative rotation, Fig. 01b.

c. **T/F:** At rotating surfaces, the friction ( $\vec{F}$ ) is tangential to the rotating surface circle of radius  $r$ . The point of tangency is such that the moment of the force about the centre opposes the relative rotation, Fig. 01c.

• **Extension**

Extension questions require selecting the right option for completing a principle, definition, theorem, formula, approach and etc; e.g.:

A kinematical chain is called a mechanism when:

- a. the frame link is specified. d. the driven links are specified.
- b. there is one fixed or stationary link. e. its motion is known.
- c. there is one driving link. f. its locus is specified.

**3.2.2.2 The MC questionnaire for the problem part- example**

• **Extension**

The variation of the driving torque;  $T_d$  and resisting torque;  $T_r$ , of a machine shaft with a mean speed;  $\omega_m$  is shown in Fig. 04. The moment of inertia of the machine is negligible.

Select the best answer option for completing the solution used for determining the moment of inertia;  $I_f$  of a flywheel attached to the machine shaft to keep the coefficient of speed fluctuation of the machine at the value of  $\delta$ .

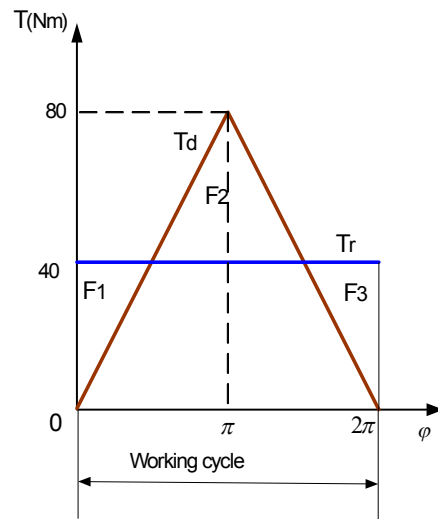
The moment of inertia of the flywheel;  $I_f$ , is determined with the following formula:

$$I_f = \frac{U}{\delta \omega_m^2}, \text{ where } U \text{ is the excess}$$

energy absorbed by the flywheel and determined as below:

a.  $U = C \text{ area } F2 \quad C = 40 \times \frac{\pi}{2} = 20 \pi \text{ J c.}$

$U = C \text{ area } F3 \quad C = 40 \times \frac{\pi}{4} = 10 \pi \text{ J}$

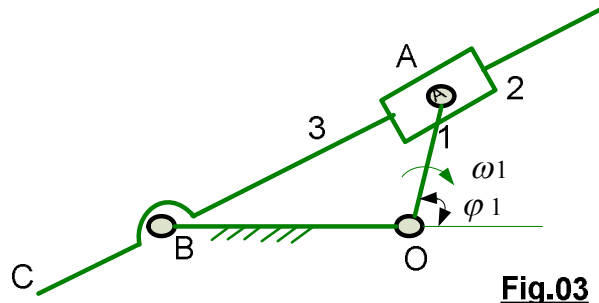


**Fig.04**

b.  $U = C \text{ area F1 C} = 40 \times \frac{\pi}{4} = 10\pi \text{ J}$  d.  $U = C \text{ area F1 C} + C \text{ area F2 C} + C \text{ area F3 C}$

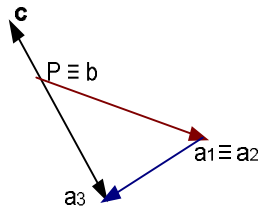
• **Most Accurate**

Which of the following options is the best approach for finding the velocity of point C in a mechanism with driving link's position;  $\phi_1$ , constant angular velocity;  $\omega_1$ , and all necessary dimensions as shown in Fig. 03 ?

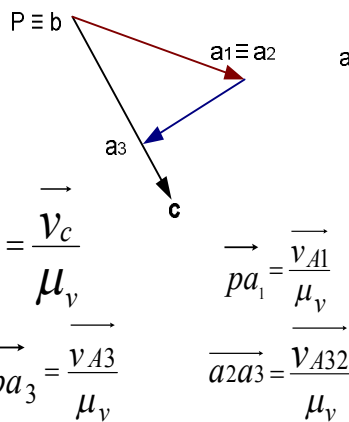


**Velocity diagram to scale  $\mu_v$**

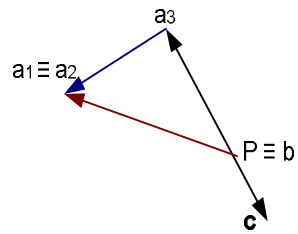
**Fig.03a**



**Fig.03b**



**Fig.03c**



**Vector equations of velocities: | On velocity diagram to scale  $\mu_v$ , Fig. 03a,b,c.**

- (1)  $\vec{v}_{A1} = \vec{v}_{A2} = \vec{\omega} \cdot OA$ ;  $\vec{v}_{A1} \perp OA$  |  $\vec{pa}_1 = \vec{pa}_2 = \vec{v}_{A1} / \mu_v$
- (2)  $\vec{v}_{A3} = \vec{v}_{A2} + \vec{v}_{A32}$ ;  $\vec{v}_{A32} \parallel AB$ ; |  $\vec{pa}_3 = \vec{pa}_2 + \vec{a_2a_3}$ ;  $\vec{pa}_3 = \frac{\vec{v}_{A3}}{\mu_v}$
- (3)  $\vec{v}_{A3} = \vec{v}_{AB}$ ;  $\vec{v}_{AB} \perp AB$ ; |  $\vec{pc} = \vec{v}_C / \mu_v$ ;  $\vec{pa}_3 = \vec{v}_{A3} / \mu_v$
- (4)  $\vec{v}_C = -\vec{v}_{A3} \cdot \frac{CB}{AB}$ ;  $\vec{v}_C \perp AB$   $\therefore$  (5)  $pc = ba_3 \cdot \frac{CB}{AB} = pa_3 \cdot \frac{CB}{AB}$

a. Approach 1:  $\vec{v}_C = \vec{pc} \cdot \mu_v$  (shown in Fig 03.a)

b. Approach 2:  $\vec{v}_C = \vec{pc} \cdot \mu_v$  (shown in Fig 03.b)

c. Approach 3:  $\vec{v}_C = \vec{pc} \cdot \mu_v$  (shown in Fig 03.c)

#### **4. Organization of MC-EW combined exams**

##### **4.1 Forms of combining the MC component questions with EW component questions in combined exam questionnaires**

The percentage of combination can be different as 30% MC - 70% EW, 40% MC - 60% EW, and 50% MC - 50% EW.

And also, the content of combination can be various as below:

1. 30% MC theory - 70% EW (20% theory + 50% problem)
2. 50% MC theory - 50% EW problem
3. 30% MC problem - 70% EW (50% theory + 20% problem)
4. 40% MC problem - 60% EW theory
5. 50% MC problem - 50% EW theory

##### **Notes:**

In fact, it depends on the specific requirements of each technical subject, the percentage of the theory and problem can be regulated.

##### **4.2 Performance of combined exams**

To ensure the reliability of exam results, the MC - EW exam questionnaires, especially, the MC ones must be renewed almost every year. Although the renewal of them on computer is not so hard, but copies of new exam questionnaire sets cost a lot (the financial condition of VIMARU cannot afford it). To avoid doing it too often, the EW and the MC questionnaire sets are made as two separate parts. In this way, the combination of the two parts can be changed variously. Besides, the MC questionnaire sets are so prepared that they can be reused for some more times. At an exam, the chosen answer option to each MC question is written down on the exam paper instead of marking right away on the questionnaire set; e.g., 1-a, 2-d, 3-f, 4-b, etc (1, 2, 3, 4, etc, - the question order numbers and a, d, f, b, etc,- the chosen answer options respective to the questions), and then, the same exam paper is used for EW questions. After each exam, the whole MC - EW exam questionnaire sets together with the exam paper must be handed in.

##### **5. Final conclusion**

1. After successive experiments on Mechanics of Machines, the examination reform with MC-EW combined exam forms was fruitful. The experience received from the experiments is quite reliable to apply not only to Mechanics of Machines but also all other technical subjects.

2. It depends on the specific requirements of each technical subject; the MC- EW combined exam forms can be applied to midterm and final exams with MC component from 30% up to 50%. The option of 50% MC is suggested.

3. To ensure the reliability of the exam results, the MC- EW combined exam questionnaires must be well prepared and renewed quite often, especially, the questionnaires of the MC component.

4. The reformed exam results are more objective and more reliable than those of traditional single oral, essay writing and multiple choice exams.

5. The MC exam questions for the part of subject problems are quite truthful for evaluating the examinees' knowledge on a technical subject.

6. The processes of doing exams and marking exam papers are less tiresome and less time-consuming.

7. The process of marking exam papers of MC component can be partially or fully automated with the help of keys or machines.

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